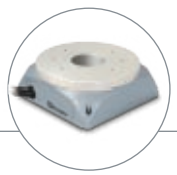
MDC Family

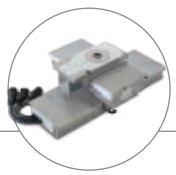
MDC1400 & MDC1800
Reference & Maintenance Manual

Primatics

Linear Positioning


Rotary Positioning

Motion Controls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MDC1400 & MDC1800 Manual
Revision Information

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October 2003	First Release
July 2004	Correct Formatting and Typos
April 2005	Updated Look & Formatting
August 2005	Correct errors for MDC1800 and I/O
January 2006	Revised Table 6-4
November 2006	Updated Chassis Dimensions
June 2007	Updated Figure 6-5, Added Programming Port Table
October 2007	Added Motion Control Card connection section
March 2008	Incorporated Aux Encoders into Section 8.1

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For additional specifications, dimensioned drawings and additional information, refer to the MDC1400 & MDC1800 Datasheets available from our website at www.primatics.com.

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1) Overview

This user guide is designed to help you install and maintain your MDC Series motion control. Follow these steps to ensure correct installation and maximum life:

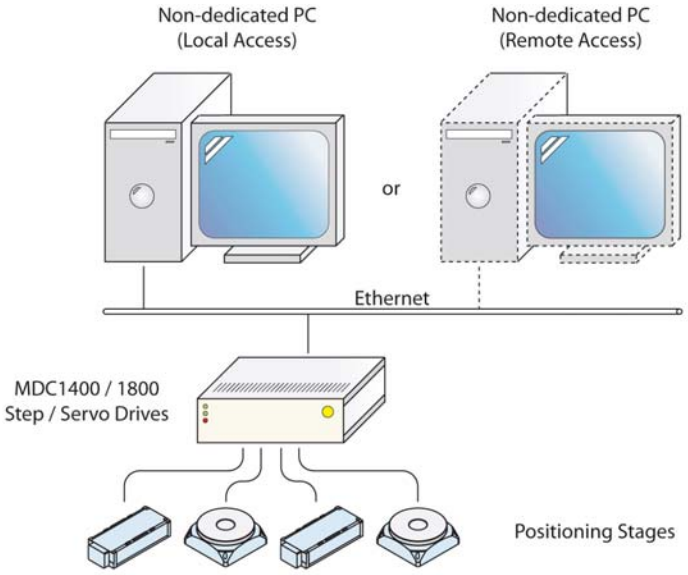
Step 1 Review this entire user manual. Become familiar with all installation procedures prior to integrating your system.

Step 2 Review the safety summary to develop an understanding of standard safety practices when installing and operating automated equipment.

Step 3 Review installation procedures. For best results, follow these procedures carefully.

2) Introduction – About the MDC1400 & MDC1800

This manual is intended for use by application engineers and technicians involved with Primatics positioning equipment.



The MDC1400 and MDC1800 Series Motor Drive Chassis are programmable multi-axis motion controllers. They are modular system that package motor drivers, encoder interfaces, power supplies and safety systems into a single chassis. A Galil DMC-21x3 Series Motion Control Card is integrated into the Chassis. Third party positioning stages or axes can be operated from a properly configured MDC. A variety of cable assemblies are available to connect a positioning stage or axis to the MDC.

The integrated Galil DMC-21x3 programmable motion control card makes the MDC1400/1800 a powerful element in a motion control system. DMC-21x3 can be programmed via its integrated RS-232 or Ethernet connection. The controller can be operated as a peripheral to the User's host computer or as a stand alone system using its internal program memory storage capability. The Galil DMC-21x3 is a multi-tasking, multi-axis, high performance motion controller. Refer to the Galil DMC-21x3 programming and users manuals for more information. Note that the "x" in the Galil nomenclature stands for the number of axes available for use.

There are two basic versions of the MDC1400/1800:

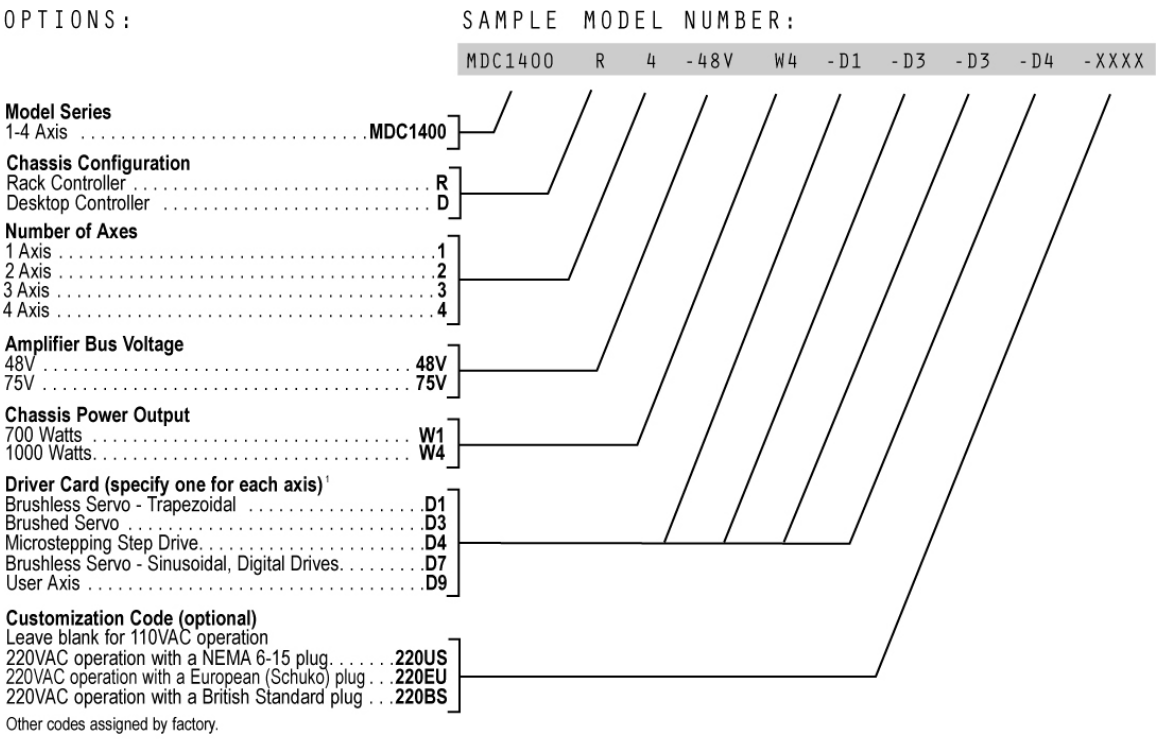
MDC1400 for 1 to 4 drive axes in a 3U chassis
MDC1800 for 1 to 8 drive axes in a 6U chassis

The basic MDC models are configured with a motor power supply, motion controller and motor drives. They can support a mix of servo and stepper drives in one package. Refer to the Model Configurations on the following pages for more information.

Custom versions of the MDC are also available to meet specific application needs including versions without an integrated programmable motion controller. Addendums to this manual will be included for custom configurations.

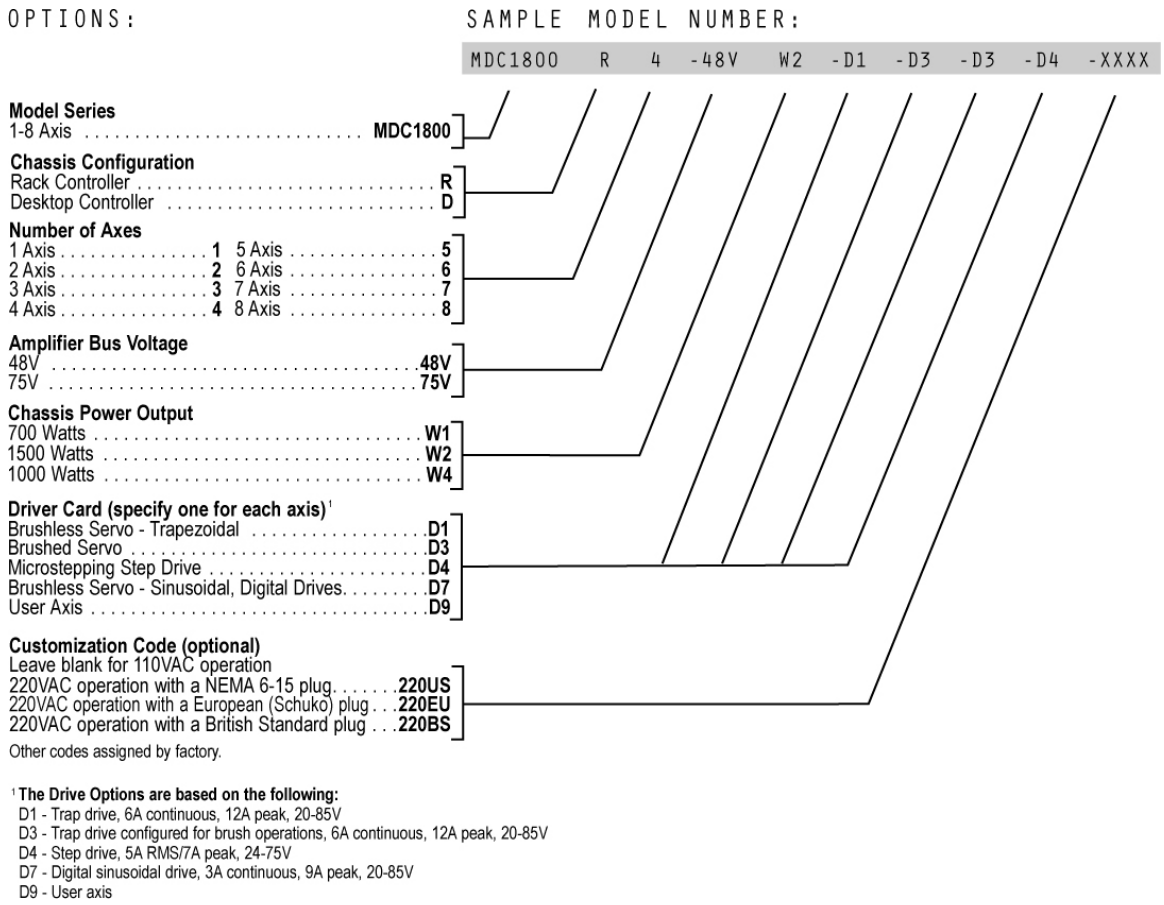
3) Model Configuration

3.1) MDC1400


OPTIONS:
SAMPLE MODEL NUMBER:
MDC1400 R 4 -48V W4 -D1 -D3 -D3 -D4 -XXXX
Model Series
1-4 Axis MDC1400
Chassis Configuration
Rack Controller ..... R
Desktop Controller ..... D
Number of Axes
1 Axis 1
2 Axis 2
3 Axis 3
4 Axis 4
Amplifier Bus Voltage
48V 48V
75V 75V
Chassis Power Output
700 Watts W1
1000 Watts W4
Driver Card (specify one for each axis)[1]
Brushless Servo - Trapezoidal D1
Brushed Servo D3
Microstepping Step Drive D4
Brushless Servo - Sinusoidal, Digital Drives D7
User Axis D9
Customization Code (optional)
Leave blank for 110VAC operation
220VAC operation with a NEMA 6-15 plug 220US
220VAC operation with a European (Schuko) plug ... 220EU
220VAC operation with a British Standard plug ... 220BS
Other codes assigned by factory.

[1] **The Drive Options are based on the following:**
D1 - Trap drive, 6A continuous, 12A peak, 20-85V
D3 - Trap drive configured for brush operations, 6A continuous, 12A peak, 20-85V
D4 - Step drive, 5A RMS/7A peak, 24-75V
D7 - Digital sinusoidal drive, 3A continuous, 9A peak, 20-85V
D9 - User axis

3.2) MDC1800


OPTIONS:
SAMPLE MODEL NUMBER:
MDC1800 R 4 -48V W2 -D1 -D3 -D3 -D4 -XXXX
Model Series
1-8 Axis MDC1800
Chassis Configuration
Rack Controller ..... R
Desktop Controller ..... D
Number of Axes
1 Axis ..... 1 5 Axis 5
2 Axis ..... 2 6 Axis 6
3 Axis ..... 3 7 Axis 7
4 Axis ..... 4 8 Axis 8
Amplifier Bus Voltage
48V 48V
75V 75V
Chassis Power Output
700 Watts W1
1500 Watts W2
1000 Watts W4
Driver Card (specify one for each axis)[1]
Brushless Servo - Trapezoidal D1
Brushed Servo D3
Microstepping Step Drive D4
Brushless Servo - Sinusoidal, Digital Drives. D7
User Axis D9
Customization Code (optional)
Leave blank for 110VAC operation
220VAC operation with a NEMA 6-15 plug. 220US
220VAC operation with a European (Schuko) plug ... 220EU
220VAC operation with a British Standard plug ... 220BS
Other codes assigned by factory.

[1] **The Drive Options are based on the following:**
D1 - Trap drive, 6A continuous, 12A peak, 20-85V
D3 - Trap drive configured for brush operations, 6A continuous, 12A peak, 20-85V
D4 - Step drive, 5A RMS/7A peak, 24-75V
D7 - Digital sinusoidal drive, 3A continuous, 9A peak, 20-85V
D9 - User axis

⚠ 4) Personal Safety ⚠

Please review before installing your motion system

Observe common industrial safety practices when installing and operating automated equipment.

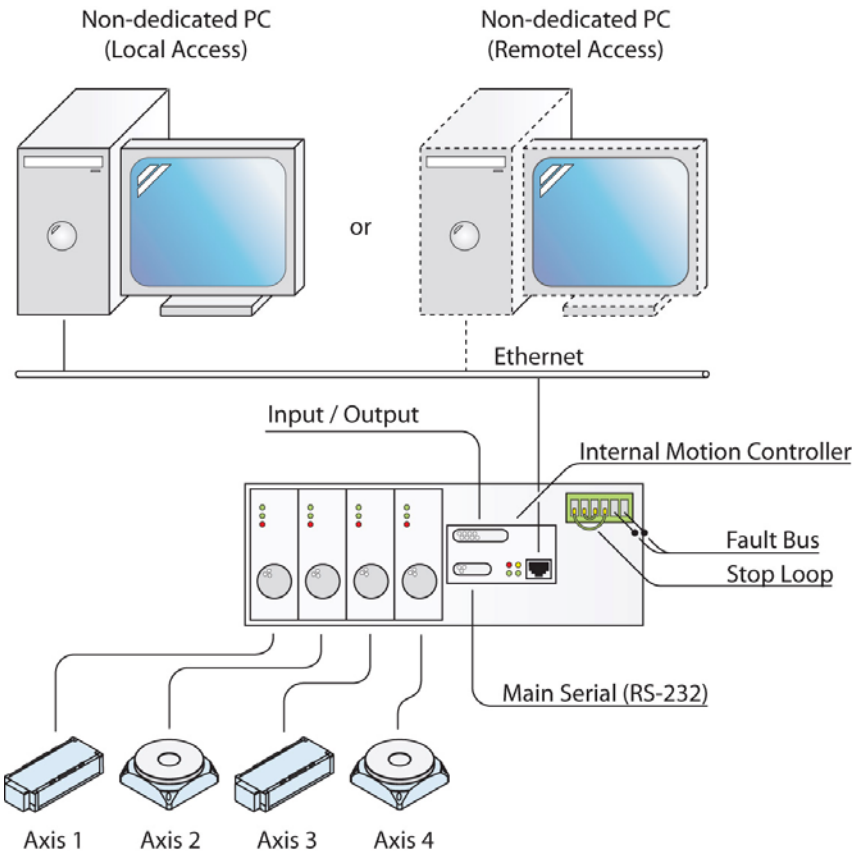
- Have power connections made by qualified personnel.
- Keep fingers and other items out of any opening in the stage while it is in operation since injury or damage may result.
- Provide a safe access route and adequate room for servicing.
- Perform the recommended periodic maintenance described in this document.
- Verify that the work envelope is free of obstructions before the positioning stage is powered.
- Insure that for servo motors the encoder must be working properly and the polarity of the encoder needs to match the polarity of the motor before enabling the servo drive. Improper feedback connections can cause a motor run-away condition that has the potential to damage the stage and injure an operator.
- Only trained operators of the positioning stage should be allowed near the work environment.
- Identify emergency stop circuits and actuators in the workcell. In an emergency press the yellow stop button on the drive chassis front panel. This cuts power to all axes amplifiers.
- Note the places in the workcell where pinch points occur, and provide adequate safety clearance or safety curtain.
- Never operate the motor in a location that could be splashed by water, exposed to corrosive or flammable gases or is near combustible substances since this may cause an electric shock, fire or malfunction.
- Never touch the motor, driver, or peripheral devices when the power is on or immediately after the power is turned off. The high temperature of these parts may cause burns.

5) Installation

5.1) Locating the MDC

A typical motion system consists of the MDC, axis cables and positioning stages. The Motion Controller Card is housed inside the MDC. The MDC also includes Motor Drive Cards for each axis of travel; these Motor Drive Cards connect to stages with axis cables. Figure 5-1 shows a typical system using the MDC1400.

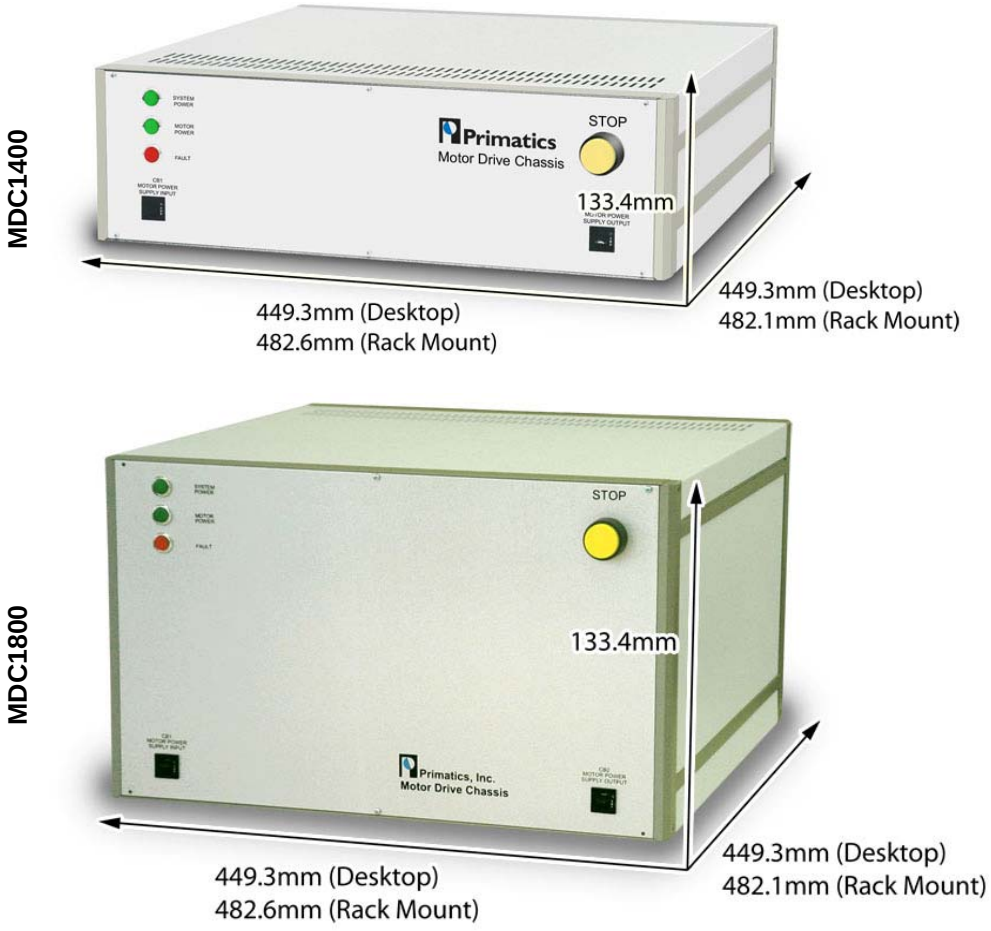
Figure 5-1: MDC1400 Motion System



The MDC must be placed in a convenient location for connection to both the motion control card and your stages. Access to the front panel controls and the rear panel connectors must be considered before installation. There are no user serviceable parts in the chassis, but axis cards are “plug-in” assemblies that can be removed and installed from the rear of the chassis.

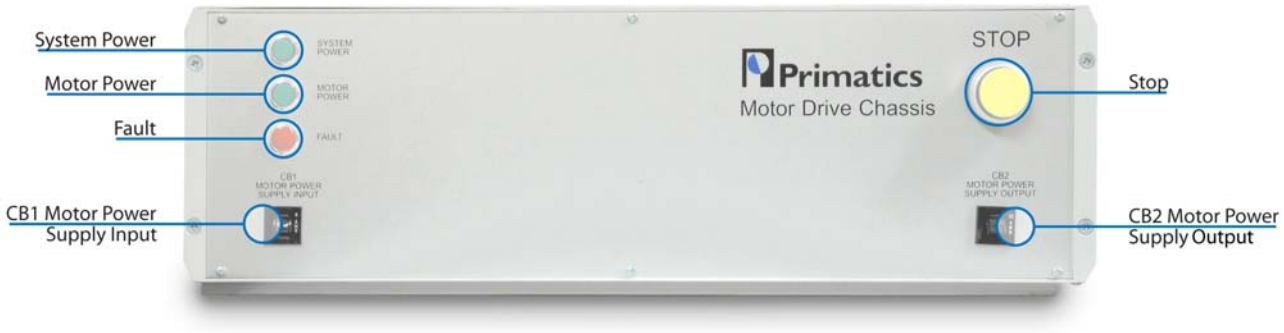
Both desktop and rack mount model dimensions can be found in Figure 5-2. The rack mount chassis includes mounting flanges for securing the chassis in an equipment rack.

Figure 5-2: Dimensions of MDC



5.2) Front Panel Indicators and Controls

Figure 5-3: Front Panel



SYSTEM POWER is illuminated whenever power is applied to the chassis, and the power switch on the rear is turned on.

MOTOR POWER is illuminated when the internal motor power supply is turned on.

FAULT is illuminated whenever any condition exists that prevents the motor power supply to be turned on.

STOP is connected into the Safety Port on the rear panel described in Section 5.3.1.

CB1 is a circuit breaker for the input to the motor power supply.

CB2 is a circuit breaker for the output of the motor power supply.

5.3) Rear Panel Information

All connections to the MDC are made at the Rear Panel. Figures 5-4 and 5-5 show the Rear Panel views of a typical MDC1400 & MDC1800, respectively. Note that the Motor Drive Cards (Axis Cards) are identified as Axes 1 through 8. The Galil Motion Controller will associate the drive card in Axis 1 with Galil Axis A, the drive card in Axis 2 with Galil Axis B, and so on.

Figure 5-4: Axis Cards and Motion Control Card Association in MDC1400

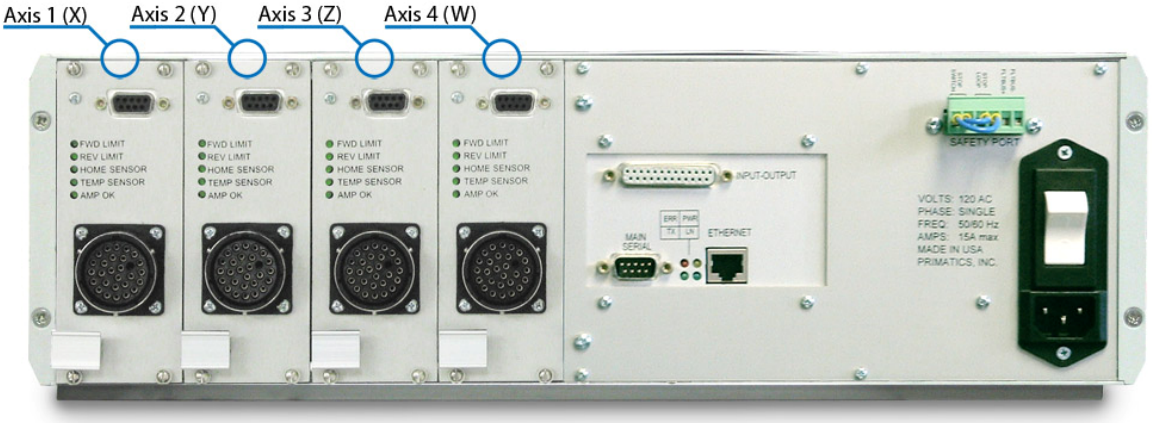
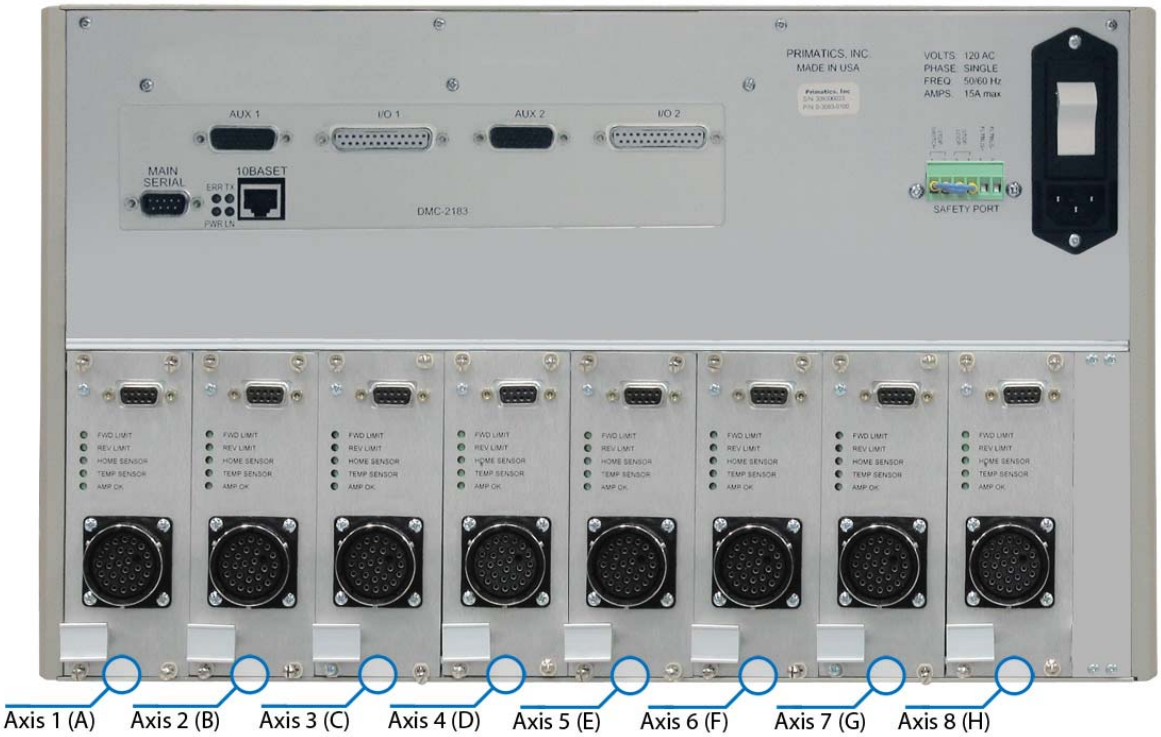


Figure 5-5: Axis Cards and Motion Control Card Association in MDC1800



5.3.1) The Safety Port

At the rear of the MDC is a pluggable terminal strip labeled Safety Port (see Figure 5-6). The Safety Port has two functions: connecting the MDC into the safety system of an application (Stop Loop) and interlocking the safety circuits in multiple MDC systems (Fault Bus).

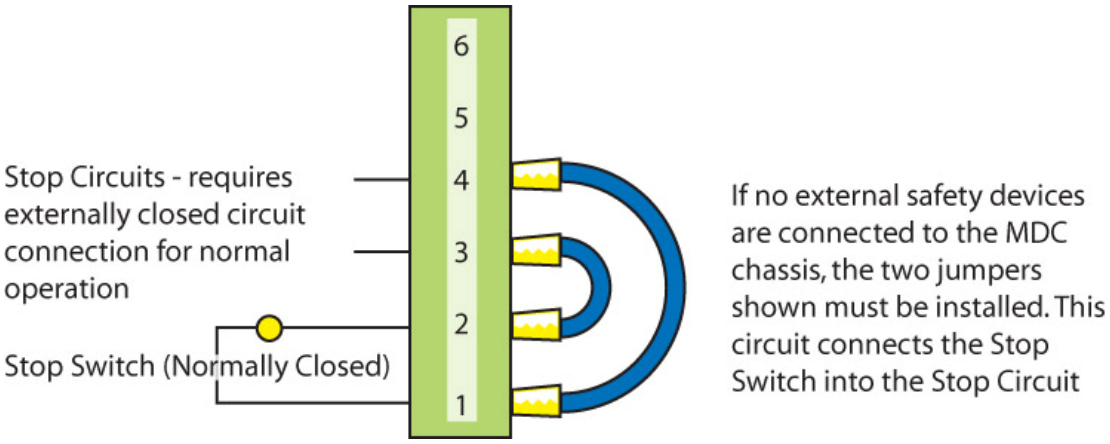
Figure 5-6: Safety Port

5.3.1.1) Stop Loop and Stop Switch

To enhance the safety of an application, the motor power supply in the MDC uses an external Stop Loop to control the state of its motor power circuit. For normal operation of the motor power supply, the Stop Loop found on pins 3 and 4 of the Safety Port must form a closed circuit. An open Stop Loop will generate internal STOP and hardware faults, killing power to the motors.

The Stop Switch on the front panel of the MDC chassis is a normally closed switch connected between pins 1 and 2 of the Safety Port. If no external devices are to be connected to the Stop Loop, the Stop Switch must be connected as shown in Figure 5-7.

Figure 5-7: Stop Switch and Stop Loop connections (pins 1, 2, 3 and 4 of Safety Port)

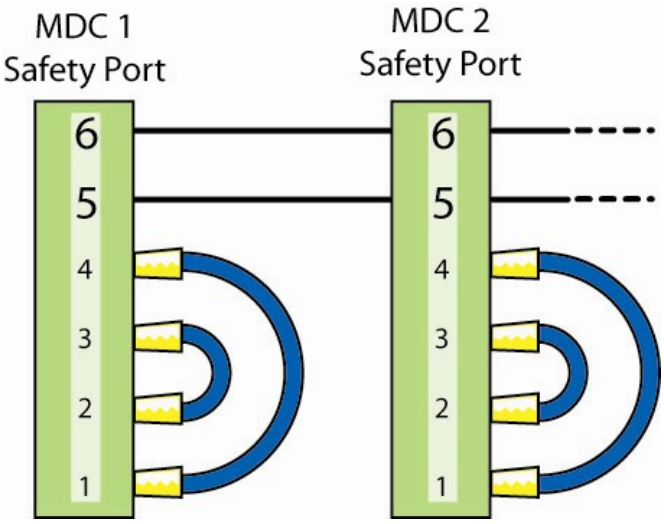

6
5
4
3
2
1
Stop Circuits - requires externally closed circuit connection for normal operation
Stop Switch (Normally Closed)
If no external safety devices are connected to the MDC chassis, the two jumpers shown must be installed. This circuit connects the Stop Switch into the Stop Circuit

To connect the MDC safety system to external devices, such as an external STOP switch, light curtain, etc, insert the normally closed circuit from the safety devices into one of the two loops show in Figure 5-7. Assure that the safety circuit is a dry contact.

5.3.1.2) Fault Bus

The Fault Bus is used to propagate internal hardware faults from one MDC to another. A multiple MDC system can use the Fault Bus on pins 5 and 6 of the Safety Port to connect the safety systems between MDC chassis. In such a system, connect the Fault Buses as shown in Figure 5-8. When multiple MDCs are connected to the Fault Bus, an ESTOP or other hardware faults in one MDC will cause a hardware fault in all other MDCs on the bus. Up to four MDCs can be connected with the Fault Bus. *Single MDC systems have no connection to the Fault Bus.*

Figure 5-8: Fault Bus Connections (pins 5 & 6 of Safety Port)



6) Connecting Motors to the MDC

IMPORTANT
ALL CONNECTIONS ARE TO BE MADE WITH NO POWER APPLIED TO THE MDC

This section contains information about all of the drive card options. It includes pin-outs of the cable connectors on each card as well as specifications. *Note that some of the information may not apply to your specific MDC.*

An axis consists of a motor, encoder, forward limit, reverse limit, home sensor, and motor temperature switch. All servo axes require encoder feedback. For step axes this feedback is optional.

Different drive options are available for various motor types. Table 6-1 lists the standard drive options and a description of the drive.

Table 6-1: Drive Options

Option	Drive Type	Amps	Voltage	Connector	Section
D1	Brushless Servo, Trapezoidal	6A Cont, 12A Peak	20-85 V	Brushless Servo	6.2
D3	Brushed Servo	6A Cont, 12A Peak	20-85V	Brush Servo	6.3
D4	Mircrostepping,	5A RMS, 7A Peak	24-75V	Stepper	6.4
D7	Brushless Servo, Digital Sinusoidal	3A Cont, 9A Peak	20-85V	Brushless Servo	6.5
D9	User Axis	-	-	User Axis	6.6

The following sections describe the connection for the different drive types.

6.1) D1 option: Brushless servo motor, trapezoidal drive

The D1 option is for brushless servo motors that are commutated with hall sensors (trapezoidal commutation).

Specifications:

Motor Type	Brushless servo with commutation (hall) sensors
Drive Type	PWM. 33 kHz
Current	6A cont / 12A peak
Voltage	20-80 VDC
Min Load Inductance	200 µH
Bandwidth	2.5 kHz
Connector	Servo Brushless Axis
Fuse	6A SB 5x20mm

Figure 6-1) Brushless Motor, Trapezoidal Card

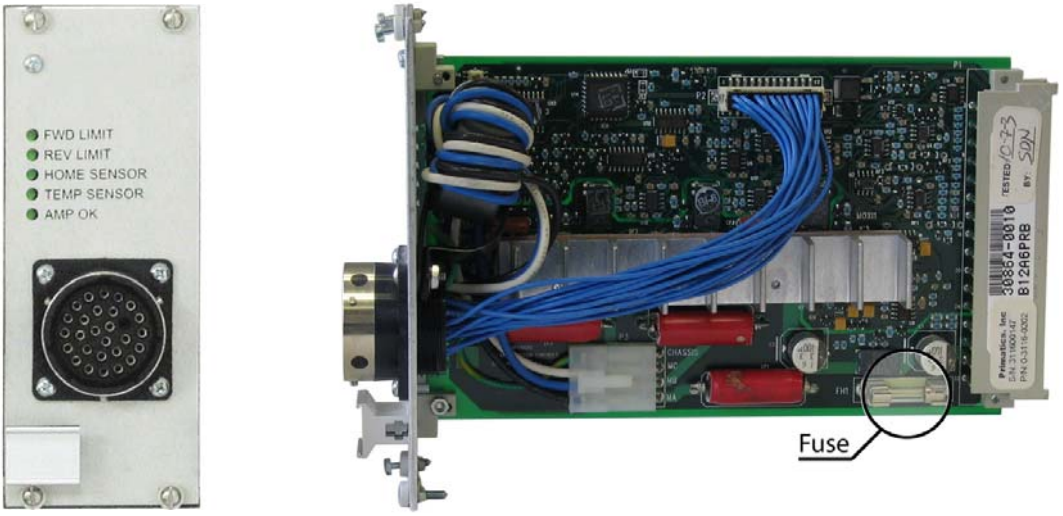


Table 6-2) Brushless Servo Axis Connector Pin-out

Pin	Name	Function
A	MOT A	Motor phase A
B	MOT B	Motor phase B
C	MOT C	Motor phase C
D	MOT SHLD	Shield for motor signals, connect to motor case.
E	ENC 5V	Encoder power supply, 5VDC
F	ENC A+	Encoder channel A+
G	ENC A-	Encoder channel A-
H	ENC B+	Encoder channel B+
J	ENC B-	Encoder channel B-
K	ENC SHLD	Shield for encoder signals, connect to encoder case.
L	LIMIT 12V	12VDC Power supply for home and limit sensors, switchable to 5V
M	LIMIT COM	power supply return for home and limit sensors.
N	HOME	Home signal input
P	BRAKE+	Failsafe brake power output, 24VDC to release brake
R	BRAKE-	return for brake power output
S	SHIELD	Shield for cable
T	HALL 5V	Hall sensor power output, 5VDC
U	HALL 0V	return for Hall sensor power output
V	ENC 0V	Return for Encoder power
W	ENC I+	Encoder channel I+
X	ENC I-	Encoder channel I-
Y	FLS	Forward limit switch input.
Z	RLS	Reverse limit switch input.
a	<key>	
b	HALL A	Hall sensor A input
c	HALL B	Hall sensor B input
d	TEMP	Motor temperature switch input. Connect to LIMIT COM for normal operation.
e	HALL C	Hall sensor C input

6.1.1) Brushless Servo Mating Connector Information

Connector Parts:
Manufacturer: ITT Cannon. Similar parts also available from FCI:

Description	Cannon P/N	Remark
Connector Body:		
Connector Body, cable mount, 28 pins	192922-1290	Mates with panel mount, 28 sockets
Backshell	192922-1350	Use with any connector body
Contacts:		
Pins, crimp, 26-24 AWG	192990-0020	Use with Crimp Tool
Pins, crimp, 22-20 AWG	192990-0040	Use with Crimp Tool
Pins, crimp, 18-16 AWG	192990-0060	Use with Crimp Tool
Pins, crimp, 16-14 AWG	192990-1240	Use with Crimp Tool
Pins, solder cup	192900-0632	Solder to conductors up to 14 AWG
Keying pin	192990-0000	Use in position ‘a’ for sevo axes
Hand Assembly Tools:		
Extraction Tool	192922-1450	Used with all contacts
Crimp Tool, ratcheted	112108-0014	Used with crimp contacts 26-16 AWG
Crimp Tool, low cost, low volume	192922-1440	Used with crimp contacts 26-14 AWG

Connector Kits:

Kit Model	Remark
Connection Kit 28-Position Pin Cable	Primatics P/N 0-3064-1300 which consists of: 1 cable mount connector body for pins 1 backshell 5 crimp pins 16-18 AWG 30 crimp pins 20-22 AWG 1 keying pin
Connection Tool Kit – Crimp and Extraction	Primatics P/N 0-3064-1400 which consists of: 1 extraction tool 1 crimp tool (low cost, low volume) Used with any of the contacts in the kits listed. Only one kit required per user and tools can be reused on many connectors

Cable Assemblies:

CABLE-SERVO-MDC-STAGE to connect MDC to Primatics Servo Axis
CABLE-SERVO-MDC-PIGTAIL to connect MDC to User Supplied Servo Axis

6.2) D3 option: Brush servo motor motors

The D3 option is for brush servo motors

Specifications:

Motor Type	Brush DC Servo
Drive Type Current	PWM. 33 kHz
Current	6A cont / 12A peak
Voltage	20-80 VDC
Min Load Inductance	200 µH
Bandwidth	2.5 kHz
Connector	Servo Brushless Axis
Fuse	6A SB 5x20mm

Figure 6-2) Brush Motor Card

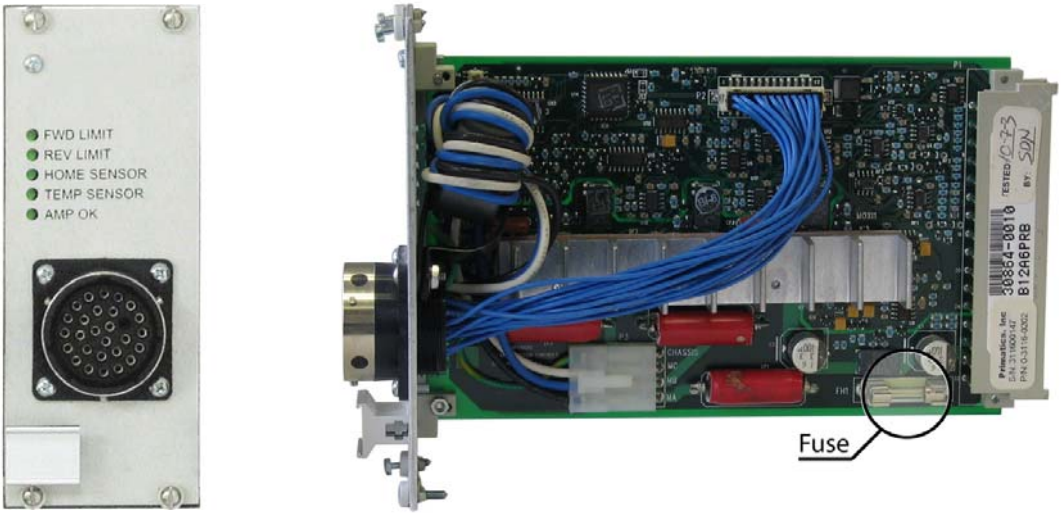


Table 6-3) Brush Servo Axis Connector Pin-out

Pin	Name	Function
A	MOT A	Motor phase A
B	MOT B	Motor phase B
C	not used	
D	MOT SHLD	Shield for motor signals, connect to motor case.
E	ENC 5V	Encoder power supply, 5VDC
F	ENC A+	Encoder channel A+
G	ENC A-	Encoder channel A-
H	ENC B+	Encoder channel B+
J	ENC B-	Encoder channel B-
K	ENC SHLD	Shield for encoder signals, connect to encoder case.
L	LIMIT 12V	12VDC Power supply for home and limit sensors, switchable to 5V
M	LIMIT COM	power supply return for home and limit sensors.
N	HOME	Home signal input
P	BRAKE+	Failsafe brake power output, 24VDC to release brake
R	BRAKE-	return for brake power output
S	SHIELD	Shield for cable
T	not used	
U	not used	
V	ENC 0V	Return for Encoder power
W	ENC I+	Encoder channel I+
X	ENC I-	Encoder channel I-
Y	FLS	Forward limit switch input. Connect to LIMIT COM for normal operation.
Z	RLS	Reverse limit switch input. Connect to LIMIT COM for normal operation.
a	<key>	
b	not used	
c	not used	
d	TEMP	Motor temperature switch input. Connect to LIMIT COM for normal operation.
e	not used	

6.2.1) Brush Servo Mating Connector Information

Connector Parts:
Manufacturer: ITT Cannon. Similar parts also available from FCI:

Description	Cannon P/N	Remark
Connector Body:		
Connector Body, cable mount, 28 pins	192922-1290	Mates with panel mount, 28 sockets
Backshell	192922-1350	Use with any connector body
Contacts:		
Pins, crimp, 26-24 AWG	192990-0020	Use with Crimp Tool
Pins, crimp, 22-20 AWG	192990-0040	Use with Crimp Tool
Pins, crimp, 18-16 AWG	192990-0060	Use with Crimp Tool
Pins, crimp, 16-14 AWG	192990-1250	Use with Crimp Tool
Pins, solder cup	192900-0632	Solder to conductors up to 14 AWG
Keying pin	192990-0000	Use in position ‘a’ for sevo axes
Hand Assembly Tools:		
Extraction Tool	192922-1450	Used with all contacts
Crimp Tool, ratcheted	112108-0014	Used with crimp contacts 26-14 AWG
Crimp Tool, low cost, low volume	192992-1440	Used with crimp contacts 26-14 AWG

Connector Kits:

Kit Model	Remark
Connection Kit 28-Position Pin Cable	Primatics P/N 0-3064-1300 which consists of: 1 cable mount connector body for pins 1 backshell 5 crimp pins 16-18 AWG 30 crimp pins 20-22 AWG 1 keying pin
Connection Tool Kit – Crimp and Extraction	Primatics P/N 0-3064-1400 which consists of: 1 extraction tool 1 crimp tool (low cost, low volume) Used with any of the contacts in the kits listed. Only one kit required per user and tools can be reused on many connectors

Cable Assemblies:

CABLE-SERVO-MDC-STAGE to connect MDC to Primatics Servo Axis
CABLE-SERVO-MDC-PIGTAIL to connect MDC to User Supplied Servo Axis

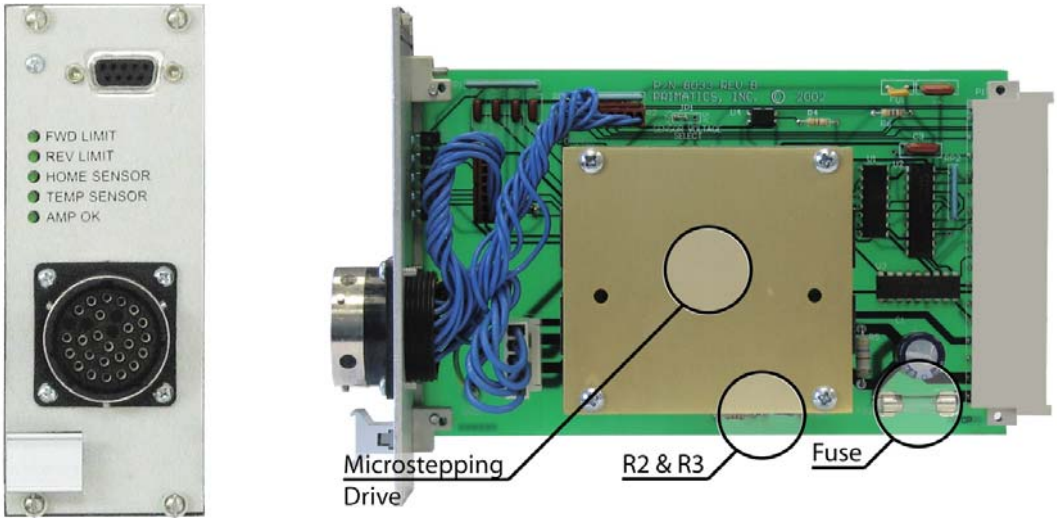
6.3) D4 option: Step Motor

The D4 option is for step motor with encoder axis. There is a protective fuse located as shown below. The step motor driver can be configured for the number of steps per revolution of the motor. The configuration is set with a 4 bit DIP switch found on the motor driver. The motor driver is attached to the Step Driver card with 4 screws shown below.

Specifications:

Motor Type	2 phase step motor
Drive Type Current	Microstepping, PWM 20 kHz
Current	1.0 to 7A peak (max 5A RMS)
Voltage	24 to 75 VDC
Max Step Freq	1.8 mHz
Microsteps / Revolution (1.8º Motor)	400, 800, 1000, 1600, 2000, 3200, 5000, 6400, 10000, 12800, 25000, 25600, 50000, 51200
Connector	Step Axis Connector
Fuse	5A SB 5x20mm

Figure 6-3) Microstepping, IMS 805 Stepper Card



Remove the screws and unplug the driver from the card. Turn the driver over and locate the DIP switch.

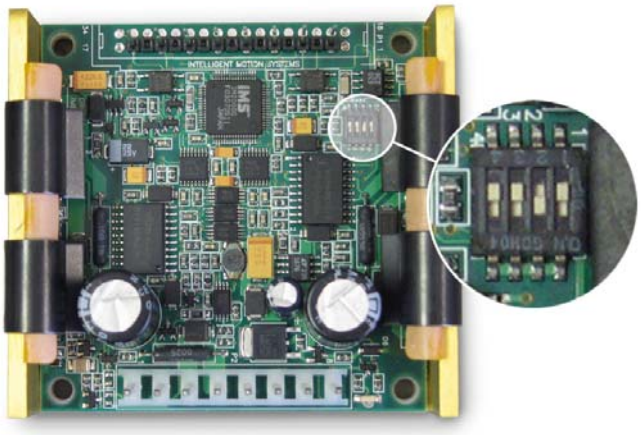


Figure 6-4) DIP switch location on driver

The step resolution is set with the switch according to the following table:

Table 6-4) Step Driver Resolution Switch

DIP switch bit		1	2	3	4
uSteps/Step	uSteps/Rev for 1.8° motor	MSEL0	MSEL1	MSEL2	MSEL3
2	400	ON	ON	ON	ON
4	800	OFF	ON	ON	ON
5	1000	ON	ON	ON	OFF
8	1600	ON	OFF	ON	ON
10	2000	OFF	ON	ON	OFF
16	3200	OFF	OFF	ON	ON
25	5000	ON	OFF	ON	OFF
32	6400	ON	ON	OFF	ON
50	10000	OFF	OFF	ON	OFF
64	12800	OFF	ON	OFF	ON
125	25000	ON	ON	OFF	OFF
128	25600	ON	OFF	OFF	ON
250	**50000**	**OFF**	**ON**	**OFF**	**OFF**
256	51200	OFF	OFF	OFF	ON

Bold = Factory Default

After the card is configured, re-install the driver onto the card. Verify that the mounting screws are tight. Install the card into the MDC chassis.

Step Motor Drive Card - Current Adjustment Resistors

The current for the step motor can be adjusted with a resistor on the Step Motor Drive card. The Drive card also features has a feature to reduce the current when a move is complete, thus reducing motor and driver heating when no motion is commanded. These currents are adjusted with two resistors on the board, R2 and R3. Let IRUN = peak running current and IHOLD = peak holding current. The resistors should have a power rating of 1/4W (or higher).

Operating Current Adjustment
The value of R2 is set for the desired operating current according to the following formula:

R2 (Ohms) = IRUN X 500
where IRUN = 1.0A min, 7.0A max

Current Reduction Resistor
The value of R3 is set for the desired holding current according to the following formula:

R3 (Ohms) = 500 X (IRUN x IHOLD) / (IRUN - IHOLD)
where IHOLD = 0.5A min, 7.0A max

Motor Inductance
The Maximum motor inductance (mH per Phase) is determined by

Max Inductance (mH per Phase) = 0.2 x Minimum Supply Voltage

Motors whose inductance exceeds the computed value will have problems moving at high speed.

Table 6-5) Step Axis Connector Pin-out

Pin	Name	Function
A	MOT A+	Motor phase A+
B	MOT B+	Motor phase B+
C	MOT B-	Motor phase B -
D	<key>	
E	ENC 5V	Encoder 5V
F	ENC A+	Encoder A+
G	ENC A-	Encoder A-
H	ENC B+	Encoder B+
J	ENC B-	Encoder B-
K	ENC SHIELD	Encoder shield
L	12VDC	12VDC Power supply for home and limit sensors, switchable to 5V
M	DCCOM	power supply return for home and limit sensors.
N	HOME	Home input. Connect to DCCOM to activate
P	BRAKE+	Fail-safe brake power output. 24VDC to release brake
R	BRAKE-	Fail-safe brake power return
S	CHASSIS	Chassis ground
T	MOT A-	Motor phase A -
U	MOT B COM	Motor Phase B common (no internal connection)
V	ENC 0V	Encoder power return
W	ENC I+	Encoder Index+
X	ENC I-	Encoder Index -
Y	FLS	Forward limit switch input. Must be connected to DCCOM for normal operation
Z	RLS	Reverse limit switch input. Must be connected to DCCOM for normal operation
a	MOT SHLD	shield for motor cable
b	MOT A COM	Motor Phase A common (no internal connection)
c	DCCOM	Power return for temperature sensor
d	TEMP	Temperature sensor input. **Must be connected to DCCOM for normal operation**
e	n/c	no connection

6.3.1) Step Mating Connector Information

Connector Parts:
Manufacturer: ITT Cannon. Similar parts also available from FCI:

Description	Cannon P/N	Remark
Connector Body:		
Connector Body, cable mount, 28 pins	192922-1290	Mates with panel mount, 28 sockets
Backshell	192922-1350	Use with any connector body
Contacts:		
Pins, crimp, 26-24 AWG	192990-0020	Use with Crimp Tool
Pins, crimp, 22-20 AWG	192990-0040	Use with Crimp Tool
Pins, crimp, 18-16 AWG	192990-0060	Use with Crimp Tool
Pins, crimp, 16-14 AWG	192990-1250	Use with Crimp Tool
Pins, solder cup	192900-0632	Solder to conductors up to 14 AWG
Keying pin	192990-0000	Use in position 'D' for stepper axes
Hand Assembly Tools:		
Extraction Tool	192922-1450	Used with all contacts
Crimp Tool, ratcheted	112108-0014	Used with crimp contacts 26-14 AWG
Crimp Tool, low cost, low volume	192992-1440	Used with crimp contacts 26-14 AWG

Connector Kits:

Kit Model	Remark
Connection Kit 28-Position Pin Cable	Primatics P/N 0-3064-1300 which consists of: 1 cable mount connector body for pins 1 backshell 5 crimp pins 16-18 AWG 30 crimp pins 20-22 AWG 1 keying pin
Connection Tool Kit – Crimp and Extraction	Primatics P/N 0-3064-1400 which consists of: 1 extraction tool 1 crimp tool (low cost, low volume) Used with any of the contacts in the kits listed. Only one kit required per user and tools can be reused on many connectors

Cable Assemblies:

CABLE-STEP-MDC-STAGE to connect MDC to Primatics Step Axis
CABLE-STEP-MDC-PIGTAIL to connect MDC to User Supplied Step Axis

6.4) D7 option: Brushless motor, digital drive

The D7 option is a digital drive for a brushless motor axis. The drive uses the hall switches and the encoder to sinusoidally commutate the drive. The drive must be programmed at the factory. There are no user configurable options for this card.

Specifications:

Motor Type	Brushless servo with sinusoidal commutation
Drive Type Current	PWM. 20 kHz
Current	3A cont / 9A peak
Voltage	20-90VDC
Bandwidth	3.0 kHz
Connector	Servo Brushless Axis
Fuse	5A SB 5x20mm

Figure 6-5) Brushless Motor, Digital Drive Card

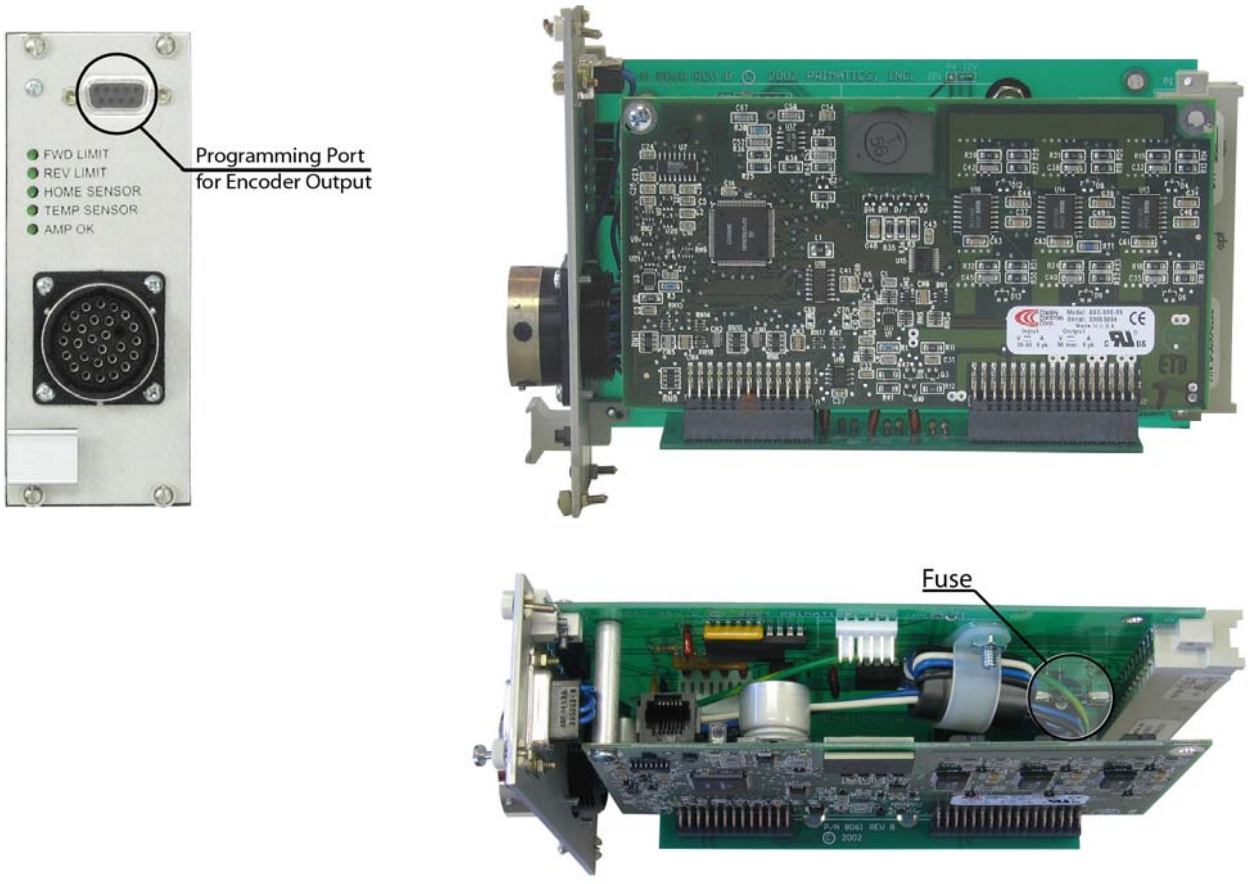


Table 6-6) Brushless Servo Axis Connector Pin-out

Pin	Name	Function
A	MOT A	Motor phase A
B	MOT B	Motor phase B
C	MOT C	Motor phase C
D	MOT SHLD	Shield for motor signals, connect to motor case.
E	ENC 5V	Encoder power supply, 5VDC
F	ENC A+	Encoder channel A+
G	ENC A-	Encoder channel A-
H	ENC B+	Encoder channel B+
J	ENC B-	Encoder channel B-
K	ENC SHLD	Shield for encoder signals, connect to encoder case.
L	LIMIT 12V	12VDC Power supply for home and limit sensors, switchable to 5V
M	LIMIT COM	power supply return for home and limit sensors.
N	HOME	Home signal input
P	BRAKE+	Failsafe brake power output, 24VDC to release brake
R	BRAKE-	return for brake power output
S	SHIELD	Shield for cable
T	HALL 5V	Hall sensor power output, 5VDC
U	HALL 0V	return for Hall sensor power output
V	ENC 0V	Return for Encoder power
W	ENC I+	Encoder channel I+
X	ENC I-	Encoder channel I-
Y	FLS	Forward limit switch input.
Z	RLS	Reverse limit switch input.
a	<key>	
b	HALL A	Hall sensor A input
c	HALL B	Hall sensor B input
d	TEMP	Motor temperature switch input. Connect to LIMIT COM for normal operation.
e	HALL C	Hall sensor C input

Table 6-7) Programming Port / Encoder Output

Pin	Name	Function
2	TxD	RS232 transmit to Drive
3	RxD	RS232 receive from Drive
5	COM	RS232 common
6	A+	Encoder output, channel A+
7	A -	Encoder output, channel A -
8	B+	Encoder output, channel B+
9	B -	Encoder output, channel B -

6.4.1) Brushless Servo Mating Connector Information

Connector Parts:
Manufacturer: ITT Cannon. Similar parts also available from FCI:

Description	Cannon P/N	Remark
Connector Body:		
Connector Body, cable mount, 28 pins	192922-1290	Mates with panel mount, 28 sockets
Backshell	192922-1350	Use with any connector body
Contacts:		
Pins, crimp, 26-24 AWG	192990-0020	Use with Crimp Tool
Pins, crimp, 22-20 AWG	192990-0040	Use with Crimp Tool
Pins, crimp, 18-16 AWG	192990-0060	Use with Crimp Tool
Pins, crimp, 16-14 AWG	192990-1240	Use with Crimp Tool
Pins, solder cup	192900-0632	Solder to conductors up to 14 AWG
Keying pin	192990-0000	Use in position ‘a’ for sevo axes
Hand Assembly Tools:		
Extraction Tool	192922-1450	Used with all contacts
Crimp Tool, ratcheted	112108-0014	Used with crimp contacts 26-16 AWG
Crimp Tool, low cost, low volume	192922-1440	Used with crimp contacts 26-14 AWG

Connector Kits:

Kit Model	Remark
Connection Kit 28-Position Pin Cable	Primatics P/N 0-3064-1300 which consists of: 1 cable mount connector body for pins 1 backshell 5 crimp pins 16-18 AWG 30 crimp pins 20-22 AWG 1 keying pin
Connection Tool Kit – Crimp and Extraction	Primatics P/N 0-3064-1400 which consists of: 1 extraction tool 1 crimp tool (low cost, low volume) Used with any of the contacts in the kits listed. Only one kit required per user and tools can be reused on many connectors

Cable Assemblies:

CABLE-SERVO-MDC-STAGE to connect MDC to Primatics Servo Axis
CABLE-SERVO-MDC-PIGTAIL to connect MDC to User Supplied Servo Axis

6.5) D9 option: User Axis

The User Axis card is used in place of an internal motor drive for connecting to an external drive or encoder. The signals from the attached motion controller are accessible on the Axis connector in Table 6-6.

Table 6-8) User Axis
Connector: DB25S
Mate: DB25P

Pin	Name	Function
1	ENC 5V	Encoder power supply, 5VDC
2	ENC A+	Encoder channel A+
3	ENC B+	Encoder channel B+
4	ENC I+	Encoder channel I+
5	FLS	Forward limit switch input. Connect to LIMIT COM for normal operation
6	HOME	Home signal input
7	CMDI	Analog toque command output, -10 to +10V
8	STEP	Step command output for Step Motors
9	GROUND	Failsafe brake release return
10	+ 12V	+12VDC supply for external circuits
11	24V	24VDC supply for external circuits
12	VMOTOR	Motor supply voltage
13	CHASSIS	Earth ground
14	GROUND	ENC 5V ground
15	ENC A-	Encoder channel A-
16	ENC B-	Encoder channel B-
17	ENC I-	Encoder channel I-
18	RLS	Reverse limit switch input. Connect to LIMIT COM for normal operation
19	AMPENA	Amplifier enable output
20	GND	Reference for analog torque command
21	DIR	Direction command output for step motors
22	BRKREL	Brake release
23	GND	Reference for +12VDC supply
24	24R	Return for 24VDC supply
25	VMCOM	Return for motor supply voltage

7) Operations

The operation and use of some features of the MDC are dependent on configuration. The operation of each drive axis is determined by the specific drive option selected. Similarly, the operation of the motion controller interface is determined by the specific version selected. However, there are many functions and features that are common to all versions and configurations including fault detection, motor power control, motor outputs, and sensor inputs. This section describes those features.

7.1) Fault Detection and Motor Power Control

For the MDC, a fault is any condition that will prevent power from being applied to the motor drives. There are two DC power systems in the MDC chassis: the Logic supply and the Motor supply. The Logic supply provides DC power to all internal circuits as well as externally connected encoders, limit and home sensors, and optional brakes. The Logic supply is on anytime AC power is supplied and the power switch is on. This condition is indicated with the illumination of the SYSTEM POWER indicator on the front panel.

The Motor supply provides the DC power to all of the motor drives. This power supply is on only if there are no fault conditions, and the motion controller has turned on the supply through its I/O signals. A fault condition will override the signals from the motion controller and turn off the motor supply. If a fault condition occurs, the source of the fault must be removed, and the condition must be re-set using I/O signals from the motion controller. The specific I/O signals and their operation are further explained in Section 8.

A Fault condition is indicated by the illuminated FAULT indicator on the front panel. This condition is caused when any of the following occur:

- System power turn-on.
- STOP LOOP on SAFETY PORT is open.
- Temperature switch input on any axis is open.

The state of the Fault as well as the cause of the fault may be determined through input signals to the motion controller.

7.2) Axis Card Indicators

FORWARD LIMIT illuminated when Forward Limit Input is closed to DCCOM

REVERSE LIMIT is illuminated when Reverse Limit Input is closed to DCCOM

HOME SENSOR is illuminated when Home Input is closed to DCCOM

TEMP SENSOR is illuminated when Temperature Input is closed to DCCOM

AMP OK is illuminated when Drive is powered on, enabled, and has no faults.

7.3) Motor Output Signals

7.3.1) Brushless Servo Motor

The brushless servo motor drives control current through the three phases of a brushless motor. For the D1 drive option, the motor is typically commutated with hall sensors or special encoder channels for this purpose. Figure 7.1 shows the timing diagram for the motor phases and commutation sensors.

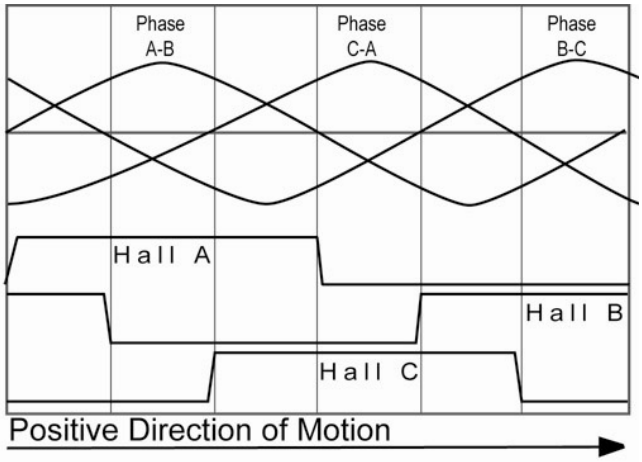


Figure 7-1: Motor commutation chart

For the D7 digital drive, the motor is initially commutated by the hall sensors, but ultimately commutated by the encoder. This drive operates the motor in sinusoidal commutation which provides for smoother operation with lower torque and velocity ripple.

7.3.2) Step Motor

The step motor drive operates 2 phase, 4 wire step motors. Both 6-wire and 8-wire motors may be used with the drive, but must be connected in a 4 wire fashion. The step motor drive is capable of micro-stepping the motor up to 256 micro-steps per step. Figure 7-2 shows the timing of the step motor drive in half-step mode (2 micro-steps per step).

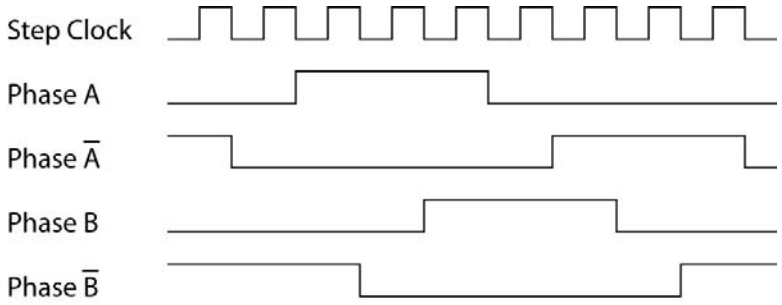


Figure 7-2: Step motor phase timing diagram for positive motion

7.4) Encoder Input

All drive card options have provision for incremental encoder position input. In the case of the servo motors, the encoder input is necessary to operate the motor. The use of the encoder input with the step motor drive is dependent on the configuration of the Galil. The encoder inputs are compatible with RS-422 differential signals commonly used on industrial encoders. Figure 7-3 shows the timing diagram for the encoder input.

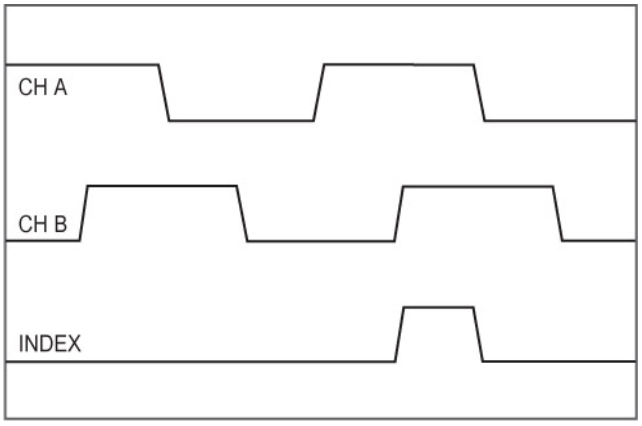


Figure 7-3: Encoder signal timing diagram for positive motion

7.5) Limit, Home & Temp Sensors

Each MDC compatible motion controller card supports monitoring a forward limit, reverse limit, and home sensor for each axis. The temperature switch input on each motor drive card exists to enhance the operational safety of an axis and is monitored by the Fault detection circuits discussed in Section 7.1. Figure 7-4 shows an equivalent schematic for the limit, home, and temperature inputs. Note that the MDC has a 12V supply available to power external sensor circuits.

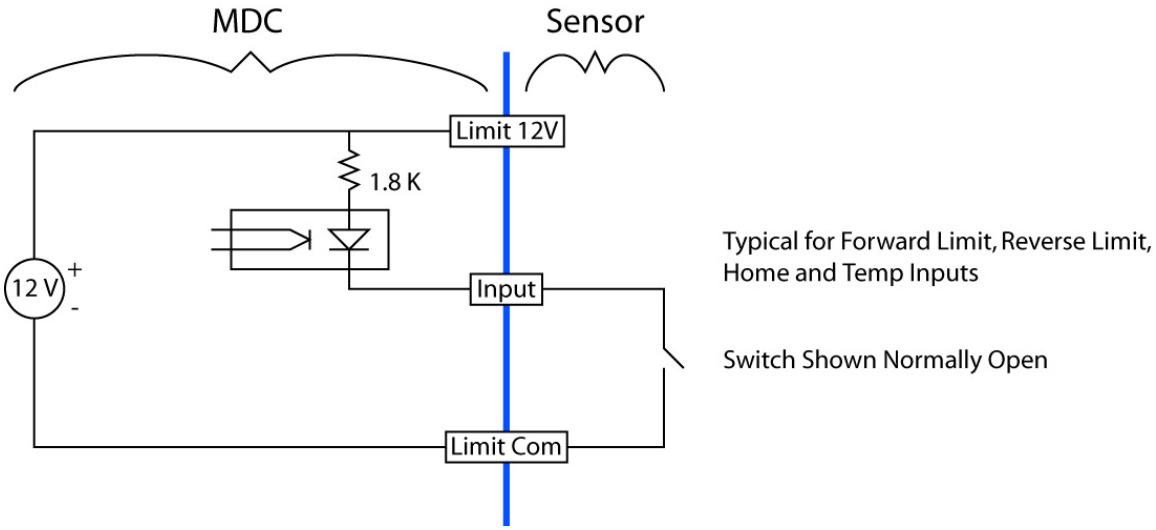


Figure 7-4: Sensor Input Circuit Diagram

7.6) Brake Release Output

Each drive card includes a circuit to energize (supply power to) a fail-safe brake. A fail-safe brake will hold an axis from moving when no power is applied to the brake. The brake release output will supply 24VDC to a brake when the output is on. The brake release output is on only when all of these conditions are satisfied:

- Motor power supply is on
- The drive amplifier is enabled by the motion controller
- The drive amplifier has no faults
- The brake release enable output bit from the motion controller is on

The brake release enable output bit is described in Section 8.

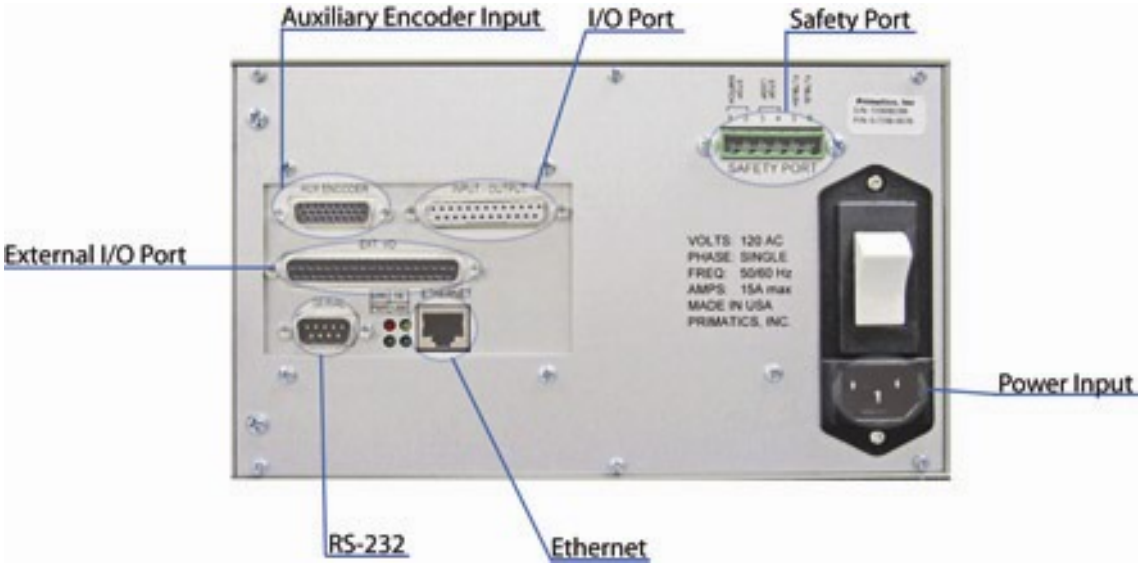
8) The Galil DMC 21x3

8.1) DMC 21x3 Connectors for the MDC1400

8.1.1) Communication Ports: RS-232, Ethernet

Communication to the integrated Galil DMC-21x3 can be via the RS-232 port or Ethernet port as indicated. The RS-232 port operates at 19.2K. The Ethernet port is a 10BaseT port. Refer to the Galil DMC-21x2/21x3 User Manual, Chapter 4 for detailed information about both of these interfaces. The factory default IP address is 192.168.0.10.

Figure 8-1: Galil Communications Connections for MDC1400



8.1.2) The I / O Port

This port provides access to certain Input, Output, Status, and Control signals from the Galil motion control card. The pin definition for this port is shown in the table below.

Please note that many of the signals in the I/O Port are TTL logic levels. Power supply signals are included in the port for users that want to provide external signal conditioning. If you want internal signal conditioning for your application, contact the factory.

Table 8-1a) I/O Port Pinout:
Connector: DB25S
Mate: DB25P

Pin	Name	Description
1	USER IN 1	TTL input
14	USER IN 2	TTL input
2	USER IN 3	TTL input
15	USER IN 4	TTL input
3	USER OUT 1	TTL output
16	USER OUT 2	TTL output
4	USER OUT 3	TTL output
17	NC	No Connection
5	NC	No Connection
18	NC	No Connection
6	NC	No Connection
19	NC	No Connection
7	NC	No Connection
20	NC	No Connection
8	NC	No Connection
21	ABORT	TTL input. Abort input of Galil card. Active low.
9	ENC CMP	TTL output. Encoder Compare output of Galil card.
22	ERROR	TTL output. Error output
10	NC	No connection
23	NC	No connection
11	+12VDC	Power supply, 12VDC, 100mA max.
24	-12VDC	Power supply, -12VDC, 100mA max.
12	GND	DC common for power supplies and signals
25	GND	see pin 12
13	5VDC	Power supply, 5VDC, 200mA max.

8.1.3) Auxiliary Encoder Input

MDC1400 provides an auxiliary encoder input for the DMC-21x3. The pin definition for these inputs is shown in the Table below.

Table 8-1b) Aux Encoder Input 1 Pinout:
Connector: High-Density DB26S
Mate: HD DB26P

Pin	Name	Description
1	ENC 5V	5V encoder poser supply
2	ENC 0V	Ground for 5V encoder power supply
3	CHASSIS	Chassis to ground encoder shield
4	ENC 5V	5V encoder poser supply
5	ENC 0V	Ground for 5V encoder power supply
6	ENC 5V	5V encoder poser supply
7	ENC 0V	Ground for 5V encoder power supply
8	ENC 5V	5V encoder poser supply
9	ENC 0V	Ground for 5V encoder power supply
10	ENC AA+	Secondary Encoder input A+ for Axis A
11	ENC AA-	Secondary Encoder input A- for Axis A
12	ENC BA+	Secondary Encoder input A+ for Axis B
13	ENC BA-	Secondary Encoder input A- for Axis B
14	ENC CA+	Secondary Encoder input A+ for Axis C
15	ENC CA-	Secondary Encoder input A- for Axis C
16	CHASSIS	Chassis to ground encoder shield
17	ENC DA+	Secondary Encoder input A+ for Axis D
18	ENC DA-	Secondary Encoder input A- for Axis D
19	ENC AB+	Secondary Encoder input B+ for Axis A
20	ENC AB-	Secondary Encoder input B- for Axis A
21	ENC BB+	Secondary Encoder input B+ for Axis B
22	ENC BB-	Secondary Encoder input B- for Axis B
23	ENC CB+	Secondary Encoder input B+ for Axis C
24	ENC CB-	Secondary Encoder input B- for Axis C
25	ENC DB+	Secondary Encoder input B+ for Axis D
26	ENC DB-	Secondary Encoder input B- for Axis D

8.1.4) External I / O Port (Optional)

This optional port provides access to bits 17 through 32 of external I/O provided by the DMC-21x3 as well as providing power supply signals for users that want to provide external signal conditioning. The pin definition for this port is shown in the Table below.

Table 8-1c) External I/O Port Pinout:
Connector: DB37S
Mate: DB37P

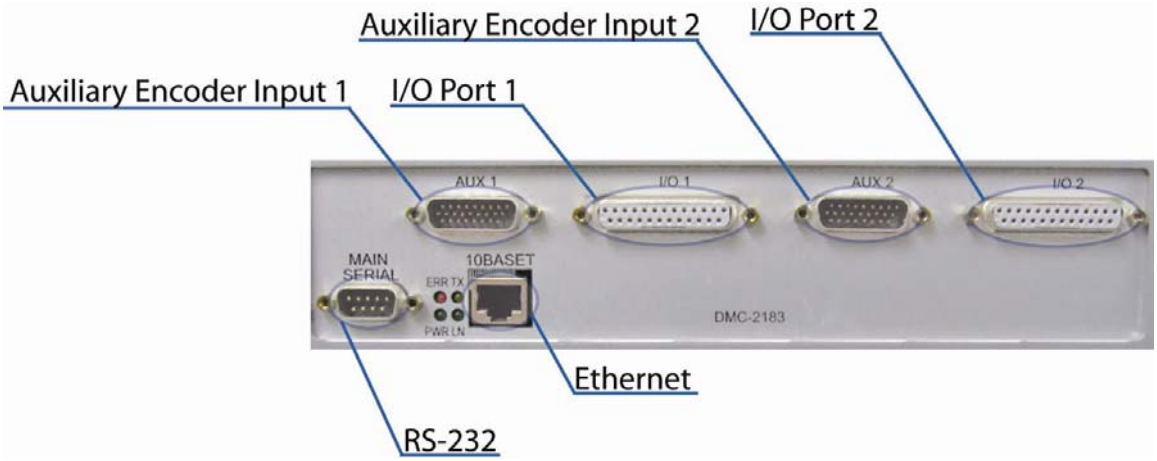
Pin	Name	Description
1	NC	No Connection
20	NC	No Connection
2	NC	No Connection
21	GND	Ground
3	BIT32	Digital I/O Bank 3 – Bit 32
22	NC	No Connection
4	BIT31	Digital I/O Bank 3 – Bit 31
23	GND	Ground
5	BIT30	Digital I/O Bank 3 – Bit 30
24	NC	No Connection
6	BIT29	Digital I/O Bank 3 – Bit 29
25	GND	Ground
7	BIT28	Digital I/O Bank 3 – Bit 28
26	NC	No Connection
8	BIT27	Digital I/O Bank 3 – Bit 27
27	GND	Ground
9	BIT26	Digital I/O Bank 3 – Bit 26
28	NC	No Connection
10	BIT25	Digital I/O Bank 3 – Bit 25
29	GND	Ground
11	BIT24	Digital I/O Bank 2 – Bit 24
30	NC	No Connection
12	BIT23	Digital I/O Bank 2 – Bit 23
31	GND	Ground
13	BIT22	Digital I/O Bank 2 – Bit 22
32	NC	No Connection
14	BIT21	Digital I/O Bank 2 – Bit 21
33	GND	Ground
15	BIT20	Digital I/O Bank 2 – Bit 20
34	NC	No Connection
16	BIT19	Digital I/O Bank 2 – Bit 19
35	GND	Ground
17	BIT18	Digital I/O Bank 2 – Bit 18
36	NC	No Connection
18	BIT17	Digital I/O Bank 2 – Bit 17
37	GND	Ground
19	5V	No Connection

8.2) DMC 21x3 Connectors for the MDC1800

8.2.1) Communication Ports: RS-232, Ethernet

Communication to the integrated Galil DMC-21x3 can be via the RS-232 port or Ethernet port as indicated. The RS-232 port operates at 19.2K. The Ethernet port is a 10BaseT port. Refer to the Galil DMC-21x2/21x3 User Manual, Chapter 4 for detailed information about both of these interfaces. The factory default IP address is 192.168.0.10.

Figure 8-2: Galil Communications Connections for MDC-1800



8.2.2) I / O Ports

These ports provide access to certain Input, Output, Status, and Control signals from the Galil motion control card. The pin definition for these ports are shown in the Tables below.

Please note that many of the signals in the I/O Port are TTL logic levels. Power supply signals are included in the port for users that want to provide external signal conditioning. If you want internal signal conditioning for your application, contact the factory.

Table 8-2a) I/O 1 Port Pinout:
Connector: DB25S
Mate: DB25P

Pin	Name	Description
1	USER IN 1	TTL input
14	USER IN 2	TTL input
2	USER IN 3	TTL input
15	USER IN 4	TTL input
3	USER OUT 1	TTL output
16	USER OUT 2	TTL output
4	USER OUT 3	TTL output
17	NC	No Connection
5	NC	No Connection
18	NC	No Connection
6	NC	No Connection
19	NC	No Connection
7	NC	No Connection
20	NC	No Connection
8	NC	No Connection
21	ABORT	TTL input. Abort input of Galil card. Active low.
9	ENC CMP	TTL output. Encoder Compare output of Galil card.
22	ERROR	TTL output. Error output
10	NC	No connection
23	NC	No connection
11	+12VDC	Power supply, 12VDC, 100mA max.
24	-12VDC	Power supply, -12VDC, 100mA max.
12	GND	DC common for power supplies and signals
25	GND	see pin 12
13	5VDC	Power supply, 5VDC, 200mA max.

Table 8-2b) I/O Port 2 Pinout:
Connector: DB25S
Mate: DB25P

Pin	Name	Description
1	USER IN 9	TTL input
14	USER IN 10	TTL input
2	USER IN 11	TTL input
15	USER IN 12	TTL input
3	USER OUT 9	TTL output
16	USER OUT 10	TTL output
4	USER OUT 11	TTL output
17	NC	No Connection
5	USER OUT 13	TTL output
18	USER OUT 14	TTL output
6	NC	No Connection
19	NC	No Connection
7	NC	No Connection
20	NC	No Connection
8	NC	No Connection
21	ABORT	TTL input. Abort input of Galil card. Active low.
9	ENC CMP	TTL output. Encoder Compare output of Galil card.
22	ERROR	TTL output. Error output
10	NC	No connection
23	NC	No connection
11	+12VDC	Power supply, 12VDC, 100mA max.
24	-12VDC	Power supply, -12VDC, 100mA max.
12	GND	DC common for power supplies and signals
25	GND	see pin 12
13	5VDC	Power supply, 5VDC, 200mA max.

8.2.2) Auxiliary Encoder Input

The MDC1800 comes with 2 D-Sub connectors that provides access to the auxiliary encoder inputs from the Galil motion control card. The pin definition for these inputs is shown in the Tables below.

Table 8-3a) Aux 1 Pinout:
Connector: High-Density DB26S
Mate: HD DB26P

Pin	Name	Description
1	ENC 5V	5V encoder power supply
2	ENC 0V	Ground for 5V encoder power supply
3	CHASSIS	Chassis to ground encoder shield
4	ENC 5V	5V encoder power supply
5	ENC 0V	Ground for 5V encoder power supply
6	ENC 5V	5V encoder power supply
7	ENC 0V	Ground for 5V encoder power supply
8	ENC 5V	5V encoder power supply
9	ENC 0V	Ground for 5V encoder power supply
10	AUX AA+	Secondary Encoder input A+ for Axis A
11	AUX AA-	Secondary Encoder input A- for Axis A
12	AUX BA+	Secondary Encoder input A+ for Axis B
13	AUX BA-	Secondary Encoder input A- for Axis B
14	AUX CA+	Secondary Encoder input A+ for Axis C
15	AUX CA-	Secondary Encoder input A- for Axis C
16	CHASSIS	Chassis to ground encoder shield
17	AUX DA+	Secondary Encoder input A+ for Axis D
18	AUX DA-	Secondary Encoder input A- for Axis D
19	AUX AB+	Secondary Encoder input B+ for Axis A
20	AUX AB-	Secondary Encoder input B- for Axis A
21	AUX BB+	Secondary Encoder input B+ for Axis B
22	AUX BB-	Secondary Encoder input B- for Axis B
23	AUX CB+	Secondary Encoder input B+ for Axis C
24	AUX CB-	Secondary Encoder input B- for Axis C
25	AUX DB+	Secondary Encoder input B+ for Axis D
26	AUX DB-	Secondary Encoder input B- for Axis D

Table 8-3b) Aux 2 Pinout:
Connector: High-Density DB26S
Mate: HD DB26P

Pin	Name	Description
1	ENC 5V	5V encoder power supply
2	ENC 0V	Ground for 5V encoder power supply
3	CHASSIS	Chassis to ground encoder shield
4	ENC 5V	5V encoder power supply
5	ENC 0V	Ground for 5V encoder power supply
6	ENC 5V	5V encoder power supply
7	ENC 0V	Ground for 5V encoder power supply
8	ENC 5V	5V encoder power supply
9	ENC 0V	Ground for 5V encoder power supply
10	AUX EA+	Secondary Encoder input A+ for Axis E
11	AUX EA-	Secondary Encoder input A- for Axis E
12	AUX FA+	Secondary Encoder input A+ for Axis F
13	AUX FA-	Secondary Encoder input A- for Axis F
14	AUX GA+	Secondary Encoder input A+ for Axis G
15	AUX GA-	Secondary Encoder input A- for Axis G
16	CHASSIS	Chassis to ground encoder shield
17	AUX HA+	Secondary Encoder input A+ for Axis H
18	AUX HA-	Secondary Encoder input A- for Axis H
19	AUX EB+	Secondary Encoder input B+ for Axis E
20	AUX EB-	Secondary Encoder input B- for Axis E
21	AUX FB+	Secondary Encoder input B+ for Axis F
22	AUX FB-	Secondary Encoder input B- for Axis F
23	AUX GB+	Secondary Encoder input B+ for Axis G
24	AUX GB-	Secondary Encoder input B- for Axis G
25	AUX HB+	Secondary Encoder input B+ for Axis H
26	AUX HB-	Secondary Encoder input B- for Axis H

8.3) Overview

The Galil DMC 21x3 series controllers provide motion control for up to eight axes of motion. Cards that support 1 to 4 axes of motion supply eight inputs and eight outputs. Cards that provide from 5 to 8 axes of motion supply 16 inputs and 16 outputs. For controllers of up to four axes, Galil uses XYZW to label axes. For controllers of more than four axes, the labels ABCDEFGH are used.

An MDC 1400 supports up to four axes of motion. Output bits 4-8 and input bits 5-8 are dedicated to providing the interface to the MDC, leaving 3 uncommitted outputs and 4 uncommitted inputs available to the user through the I/O Port.

An MDC 1800 supports up to four axes of motion. Output bits 4-8, 12,15, 16 and input bits 5-8 and 13-16 are dedicated to providing the interface to the MDC, leaving 8 uncommitted outputs and 8 uncommitted inputs available to the user through the I/O Port.

8.3.1) MDC Digital Inputs and Outputs

Five outputs are dedicated to programmatic operation of every MDC1400. Eight outputs are dedicated to programmatic operation of every MDC1800. **Motor Power Enable** and **Reset Faults** are used to control the motor power circuit. The **Brake Release Enable** is used to enable the release of failsafe brakes. The **Input Multiplexer** routes the encoder index signals to inputs allowing the user to latch the stage position corresponding to the encoder index transition. Four dedicated inputs provide MDC1400 status. Eight dedicated inputs provide MDC1800 status. The **Status Multiplexer** allows these inputs to reflect either motor power control circuit status or amplifier status.

Table 8-4) Controller Digital Outputs

	MDC 1400/1800 Outputs		**MDC 1800 only Output**
1	User Output 1	9	User Output 9
2	User Output 2	10	User Output 10
3	User Output 3	11	User Output 11
4	MDC1 Input Multiplexer	12	MDC 2 Input Multiplexer
5	MDC1 Motor Power Enable	13	User Output 13
6	MDC1 Reset Faults	14	User Output 14
7	MDC1 Status Multiplexer	15	MDC 2 Status Multiplexer
8	MDC1 Brake Release Enable	16	MDC 2 Brake Release Enable

The signals routed to the digital inputs are determined by the state of the Input Multiplexer and Status Multiplexer for each MDC.

Table 8-5) MDC1400 and 1800 Inputs

	MDC 1400/1800 Input Multiplexer Off	**MDC 1400/1800 Input Multiplexer On**
1	User Input 1	Axis A Encoder Index
2	User Input 2	Axis B Encoder Index
3	User Input 3	Axis C Encoder Index
4	User Input 4	Axis D Encoder Index
	MDC 1400/1800 Status Multiplexer Off	**MDC 1400/1800 Status Multiplexer On**
5	MDC 1 Motor Power is Off	Axis A Amp Fault
6	MDC 1 Hardware Fault	Axis B Amp Fault
7	MDC 1 ESTOP Fault	Axis C Amp Fault
8	MDC 1 Logic Power Fault	Axis D Amp Fault

Table 8-6) MDC1800 only Inputs

	MDC 1800 Input Multiplexer Off	**MDC 1800 Input Multiplexer On**
9	User Input 9	Axis E Encoder Index
10	User Input 10	Axis F Encoder Index
11	User Input 11	Axis G Encoder Index
12	User Input 12	Axis H Encoder Index
	MDC 1800 Status Multiplexer Off	**MDC 1800 Status Multiplexer On**
13	MDC 2 Motor Power is Off	Axis E Amp Fault
14	MDC 2 Hardware Fault	Axis F Amp Fault
15	MDC 2 ESTOP Fault	Axis G Amp Fault
16	MDC 2 Logic Power Fault	Axis H Amp Fault

8.3.2) Encoder Index Signals

The DMC 21x3 series of controllers allows position capture by latching. The encoder position of an axis can be latched based upon a high to low transition of the input signal corresponding to that axis. Input 1-4 corresponds to axes A-D, and inputs 9-12 (specific to the MDC1800) correspond to axes E-H. The MDC1400 makes four external input signals and four encoder index signals accessible via DMC inputs. The MDC1800 makes eight external input signals and eight encoder index signals accessible via DMC inputs. An external input signal is one that is connected to the I/O connector. The **Input Multiplexer** output selects between these sets of signals.

Note: In order to reliably capture the encoder index signal hi to low transition, the stage speed should be less than 20000 counts per second.

8.4) The MDCOptima Application Programming Interface

8.4.1) The API

The application programming interface (API) for the MDC Optima is a set of programs, which reside on the controller card. The API is written for an 8 axis system, but will operate properly for a system of 4 axis system. Axes 1-4 axis are identified as Drive 1 and axes 5-8 are identified as drive 2 in the following discussions. The programs provide motor power control, brake control, and the ability to latch encoder index signals for homing. For each program, a variable with the same name is provided to indicate routine completion. The program variable is set to 1 when the routine completes execution. A program running on the PC can set the variable to zero, execute an API routine and then poll the value of the variable to determine when the routine has finished. Appendix A contains a program listing.

8.4.2) Motor Power Control

Table 8-7) Motor Power Control Programs

Program	Description
CF	Clear faults
MPOFF	Turn motor power off
MPON	Turn motor power on
TA	Tell amplifier status
TD	Tell drive status

The **CF** program attempts to reset the hardware faults on all MDCs. First the ESTOP fault and logic power fault latches are reset and then the hardware fault latches are reset. The fault latches cannot be reset, if faults are still active.

The **MPOFF** program is used to turn off motor power to all axes. For each MDC, the **MPOFF** program turns off the enable motor power output, turning motor power off to all motor drivers (amplifiers). In addition, the Galil motor off (MO) command is issued to all axes. This turns off the amplifier enable signal and opens the servo loop for each axis.

The **MPON** program is used to turn motor power on for all axes. First it issues a Galil motor off command for all axes. This is done so that the actuators will not jump when motor power is applied. Next, the enable motor power is turned off and then on. If there are no faults, this action will turn on the motor power relay, providing power to the motor drivers. The user must then issue the Galil servo here (SH) command to activate the amplifier enable signal and close the servo loop at the current position for all axes to be powered up.

The **TA** program reports the state of each amplifier in the variable **TAVAL**. The status of axes A-H is represented in Bits 0-7, respectively. A bit value of 0 indicates the amplifier is Ok. A value of 1 indicates the amplifier is faulted.

The **TD** program reports the motor power control status bits for all MDCs in the variable **TDVAL**.

Table 8-8) TDVAL Drive Status Bits

Bit	Drive	Description	Bit = 0	Bit=1
0	1	Motor Power On?	On	Off
1	1	Hardware Ok?	Ok	Faulted
2	1	ESTOP Ok?	Ok	Faulted
3	1	Logic Power Ok?	Ok	Faulted
4	2	Motor Power On?	On	Off
5	2	Hardware Ok?	Ok	Faulted
6	2	ESTOP Ok?	Ok	Faulted
7	2	Logic Power Ok?	Ok	Faulted

8.4.3) Brakes

Table 8-9) Brake Programs

Program	Description
DBR1	Disable brake release, drive 1
DBR2	Disable brake release, drive 2
EBR1	Enable brake release, drive 1
EBR2	Enable brake release, drive 2
TBR1	Tell brake release status, drive 1
TBR2	Tell brake release status, drive 2

Each axis has a failsafe brake circuit. The brake release signal for an axis is activated if motor power is on, the amplifier is enabled and not faulted, **and** the brake release is enabled. The **DBR1** program turn off the enable brake release output for MDC1, disabling the brake release for axes A-D. The **EBR1** program turns on the brake release output for MDC1. The **TBR1** program is used to obtain the state of the brake release output. It sets the variable **TBR1VAL** to 1 if the enable brake release output is on and 0 otherwise. The programs **DBR2** and **EBR2** control the enable brake release signal for axes E-H. The program **TBR2** in conjunction with the variable **TBR2VAL** reports the status of the second brake release.

8.4.4) Latching the Encoder Index Pulse

Table 8-10) Encoder Index Latching Programs

Program	Description
ELA	Enable index pulse latch, A axis
ELB	Enable index pulse latch, B axis
ELC	Enable index pulse latch, C axis
ELD	Enable index pulse latch, D axis
ELE	Enable index pulse latch, E axis
ELF	Enable index pulse latch, F axis
ELG	Enable index pulse latch, G axis
ELH	Enable index pulse latch, H axis

The **ELA** program sets up the controller to latch the position of the axis A when the encoder index pulse makes a low to high transition. The program turns on the InputMux1 output, routing the index pulses for axes A-D to inputs 1-4 and then arms the latch for axis A. After the **ELA** program is executed, the user interrogates the Galil **AL** command to determine if the latch has occurred. After the position is latched, the Galil **RL** command is used to obtain the latched position. The programs **ELB**, **ELC**, and **ELD** all are similar, in that they require InputMux1 to be on. The programs **ELE**, **ELF**, **ELG**, and **ELH** all are similar, but they require InputMux2 to be on and route the index pulses for axes E-H to inputs 9-12 and then arms the latch for axis E, F, G or H.

Note: It is not possible to latch a position of axis A-D and simultaneously read user inputs 1-4. The same restriction holds true for axis E-H and user inputs 9-12. To read user inputs, see the user inputs section below.

8.4.5) User Inputs

Table 8-11) Input Multiplexer Disable Programs

Program	Description
DIM1	Disable input multiplex, Drive 1
DIM2	Disable input multiplex, Drive 2

Description:
The input multiplexer output for drive 1 determines whether axis A-D encoder index signals or external user inputs 1-4 are multiplexed to user inputs 1-4. The command **DIM1** disables the drive 1 input multiplexer output, causing the external input signals 1-4 to be routed to user inputs 1-4. Similarly, the command **DIM2** disables the multiplexer output for drive 2. This causes the external input signals 9-12 to be routed to user inputs 9-12.

8.5) Software Installation

This section discusses the steps required to configure motion cards for the Primatics motor drive chassis and stages. The MDCOptima API is provided on the disk labeled Primatics MDCOptima API (Part Number 0-6950-0001). One file on the disc contains motion control parameters, another file contains controller API and utility programs and another file is called README.TXT and has instructions on how to use the other two files, configure the motion control card, turn on power, close the servo loop, home the axes, set the cycle speeds, and start and stop the program. The motion control parameters used at the factory are supplied with each stage. Some parameters will need to be modified depending on the particular application (e.g. tuning parameters).

8.5.1) Set the Controller Parameters

Set the BA command to specify which axes require sinusoidal commutation. Use the CN command to specify the limit switch polarity.

8.5.2) Setting Motion Control Parameters for each axis

Appendix A contains a sample motion control parameters sheet provided with PLG and PLR series stages. Using the Galil DMC Terminal Program or the Set-up and Configure Form of the Servo Design Kit enter the motion control parameters. Don't forget to save the setting in nonvolatile memory.

8.5.3) Loading the API

To use the API, it must be included with the application code and downloaded to the motion card. The examples below are in the form of a DMC Terminal program session. In these terminal sessions, the characters typed by the user are in regular type and the controller response is in bold italics.

8.5.4) Example 1 – Brushless Servo - Trapezoidal Drive

It is an example of a controller with one brushless servo – trapezoidal drive. The drive is connected to the A (X) axis. The stage has an encoder ratio of 800 counts/mm and equipped with a failsafe brake. The following instructions are issued via the DMC Terminal program:

8.12) Controller configuration

Instruction	Interpretation
BA	All axes are cleared for sinusoidal commutation (The servo driver is of Trapezoidal type).
CN 1	Limit switches active high

8.13) Axis A configuration

Instruction	Interpretation
MTA=1	Motor type is servo
CEA=0	Main encoder and auxiliary encoder are normal quadrature.
DVA=0	Dual loop filter mode is disabled
KDA=20	Derivative constant
KPA=4	Proportional constant
KIA=1	Integrator
ILA=2	Integrator limit
TLA=9.998	Torque limit
OFA=0	Offset
ERA=800	Error limit
OEA=1	Off on error enabled
FAA=0	Acceleration feedforward
FVA=0	Velocity feedforward
ACA=2400000	Set acceleration (3000mm/sec)
DCA=2400000	Set deceleration (3000mm/sec)
MO;BN	Save parameters

8.14) Preparing the axis to move

Instruction	Interpretation
XQ#CF	Clear latched faults
XQ#TD	Obtain MDC0200 status
TDVAL= ***17.000***	Bit 0 is 1 indicating motor power is off. Bits 1, 2, and 3 are 0 indicating that there is no hardware, system power or ESTOP faults.
XQ#MPON	Enable MDC0200 power.
XQ#TD	Obtain MDC0200 status
TDVAL= ***16***	Bit 0 is 0 indicating motor power is on.
SHA	Close servo loop
XQ#TA	Obtain amplifier status
TAVAL= ***30***	Bit 0 is 0 indicating the A axis amplifier is OK.
XQ#EBR1	Activate the MDC1 failsafe brake release enable signal. Now, the axis A failsafe brake will release since motor power is on, the SH command has been issued, and the amplifier is OK.

8.15) Home using encoder latching

Instruction	Interpretation
CN,-1	Home switch active low
SPA=40000	Set speed to 50mm/sec
FEA;BGA	Move to the home sensor transition neighborhood
AMA;TPA ***-39921***	When the motion is complete, report the current position
XQ#ELA	Route encoder index signal to input 1 and arm latch
SPA=20000	Set the move speed (do not exceed 20000 counts/sec)
PRA=-8000	Setup a relative move of –10mm
BGA	Initiate move
AMA;TPA ***-47921***	When the motion is complete, report the current position
MG _ALA ***0.0***	The latch is not armed indicating the encoder index transition was detected.
RLA ***-41239***	Report the latched position.
PAA=_RLA	Setup a move to the latched position
BGA;AMA	Start move and wait for move completion
DPA=0	Define the latched position to be the home position

8.6) Appendices

8.6.1) Appendix A – MDCOptima API

```
NO ==========================
NO    Primatics, Inc.
NO    MDCOptima API
NO    Version 1.0
NO ==========================
NO -- Terminology
NO MDC0200 Motor Drive Chassis
NO x   Axis A,B,C,D,E,F,G,H
NO d   MDC0200 1,2
NO -- Programs
NO #CF Clear faults, both MDCs
NO #DBRd Turn off brake release enable, MDC0200 d
NO #DIMd Disable input multiplexer MDC0200 d
NO #EBRd Enable brake release MDC0200 d
NO #ELx Enable latching of index pulse x axis
NO #MPOFF Turn motor power off, both MDCs
NO #MPON Turn motor power on, both MDCs
NO #TA Axes amplifier status
NO  TAVAL - Bitwise amp status
NO    Bits 0 - 7 = Axes A - H, 1=Faulted
NO #TBRd Tell if brake release enable is on, MDC0200 d
```

```
NO  TBRdVAL - 1=Enable brake release output is on
NO #TD MDC0200 1 & 2 status
NO  TDVAL - Bitwise MDC0200 status
NO    Bits 0-3=MDC1, 4-7=MDC2
NO    Bit   Description       1=
NO    0,4   Motor Power On?   Off
NO    1,5   Hardware Ok?      Faulted
NO    2,6   Logic Power Ok?   Faulted
NO    3,7   ESTOP Ok?         Faulted
NO -- Labels
NO #TBR1A,#TBR2A
NO -- Variables used
NO Completion codes
NO    CF,DBR1,DBR2,DIM1,DIM2,EBR1,EBR2
NO    ELA,ELB,ELC,ELD,ELE,ELF,ELG,ELH
NO    MPOFF,MPON,TA,TBR1,TBR2,TD
NO Status variables
NO    TAVAL, TBR1VAL, TBR2VAL, TDVAL
#CF
CB6;WT100;SB6;WT100;CB14;WT100;SB14;WT100;
CB6;WT100;SB6;WT100;CB14;WT100;SB14;WT100;CF=1;EN
#DBR1
CB8;DBR1=1;EN
#DBR2
CB16;DBR2=1;EN
#DIM1
CB4;DIM1=1;EN
#DIM2
CB12;DIM2=1;EN
#EBR1
SB8;EBR1=1;EN
#EBR2
SB16;EBR2=1;EN
#ELA
SB4;CN,,-1;ALA;ELA=1;EN
#ELB
SB4;CN,,-1;ALB;ELB=1;EN
#ELC
SB4;CN,,-1;ALC;ELC=1;EN
#ELD
SB4;CN,,-1;ALD;ELD=1;EN
#ELE
SB12;CN,,-1;ALE;ELE=1;EN
#ELF
SB12;CN,,-1;ALF;ELF=1;EN
#ELG
SB12;CN,,-1;ALG;ELG=1;EN
#ELH
SB12;CN,,-1;ALH;ELH=1;EN
#MPOFF
MO;CB5;CB13;MPOFF=1;EN
#MPON
MO;CB5;CB13;WT 50;SB5;SB13;MPON=1;EN
#TA
```

```
SB7;SB15;TAVAL=@INT[_TI0/16]+(_TI1&$F0);TA=1;EN
#TBR1
TBR1VAL=1;JP #TBR1A, _OP0&128;TBR1VAL=0
#TBR1A;TBR1=1;EN
#TBR2
TBR2VAL=1;JP #TBR2A, _OP0&32768;TBR2VAL=0
#TBR2A;TBR2=1;EN
#TD
CB7;CB15;TDVAL=@INT[_TI0/16]+(_TI1&$F0);TD=1;EN
```

9) Troubleshooting & Service

9.1) Removing a Card

Step 1) Use a small blade screwdriver to loosen each screw in all four corners of the card. Note that these screws are captive screws and can not be pulled out all the way.

Figure 11-1

Step 2) Pull the card out by the handle as shown in Figure 5-11.

Figure 9-2

Step 3) To insert a new card, line up the PCB with the grooves found in the plastic guides. The plastic guides are outlined in Figure 5-12.

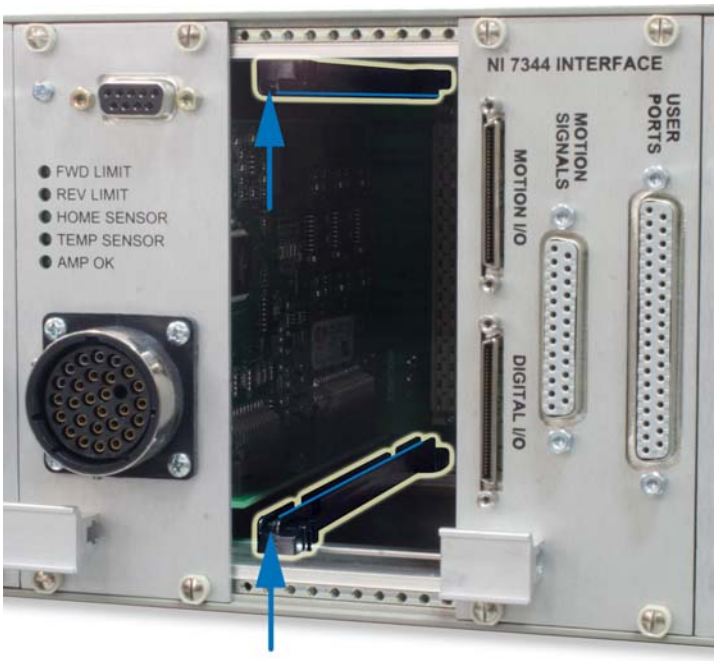


Figure 9-3

Step 4) The card should slide in with no resistance, but it should be securely within the grooves of each guide. Push the card firmly to seat it into the backplane. The cover panel will be flush with the case and other cards.

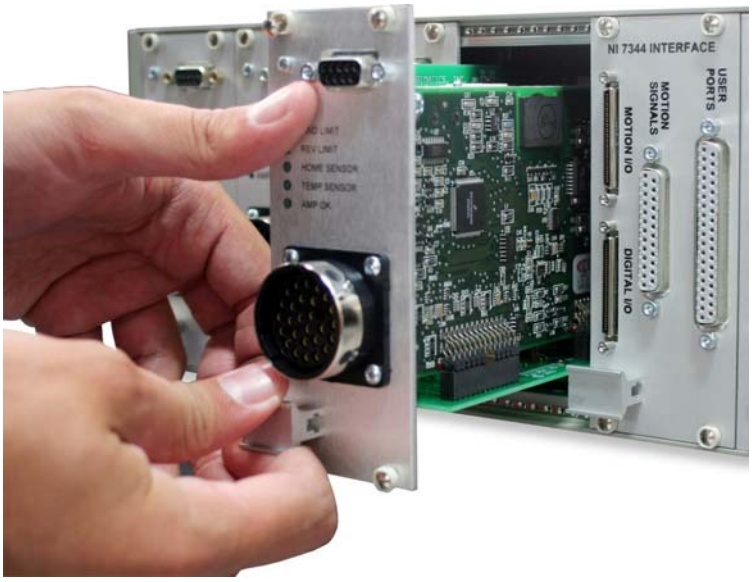


Figure 9-4

Step 5) Once in place, secure the four retaining screws.

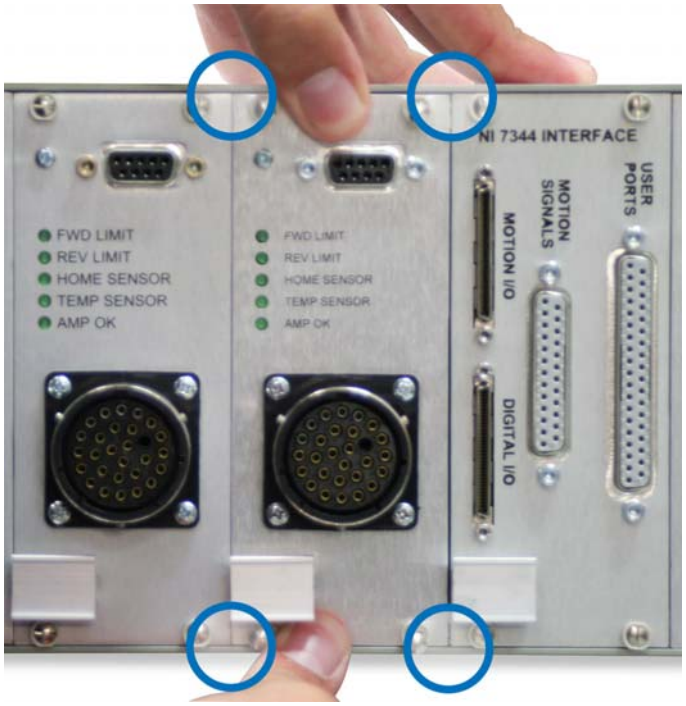


Figure 9-5

9.2) Troubleshooting Help

For further assistance contact the factory:
M-F 8AM to 5PM Pacific Time

Phone:	[541] 791-9678
Fax:	[541] 791-9410
Toll Free:	[888] 754-3111
Web:	www.primatics.com
E-mail:	service@primatics.com

9.3) Service

Should your device require factory service, contact the factory for a Return Materials Authorization (RMA). When inquiring about an RMA please have the following information available:

- Your contact information (name, phone, email, address)
- Unit Serial Number (located on label near the power switch)
- Symptom of problem
- History of troubleshooting steps already taken